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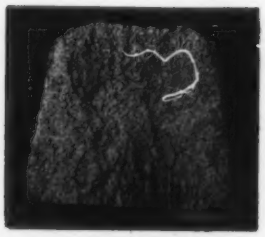

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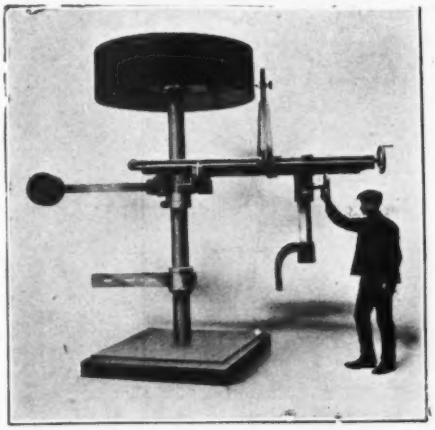

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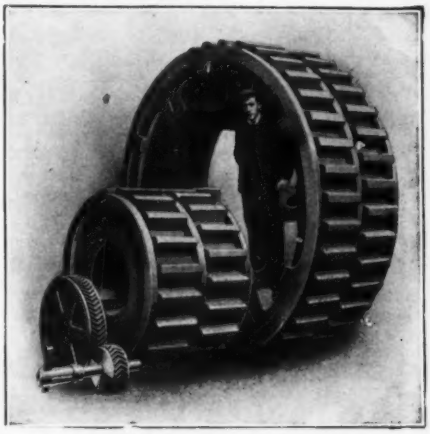

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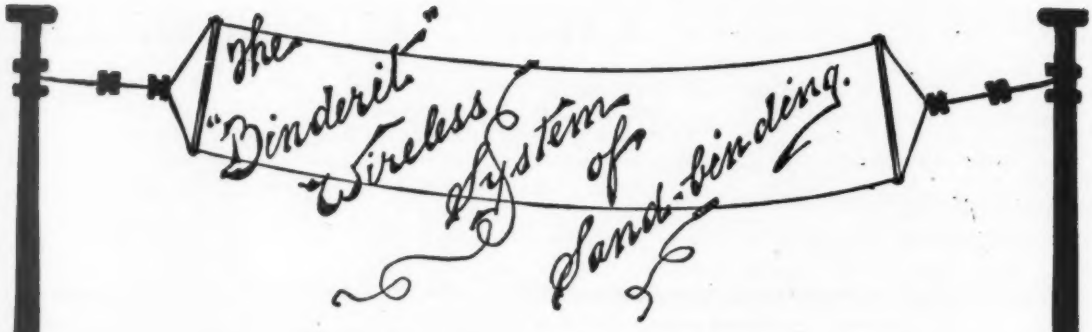


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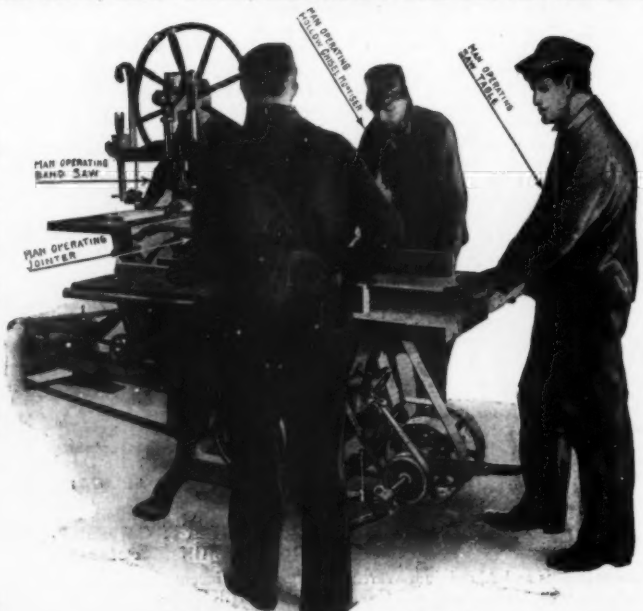


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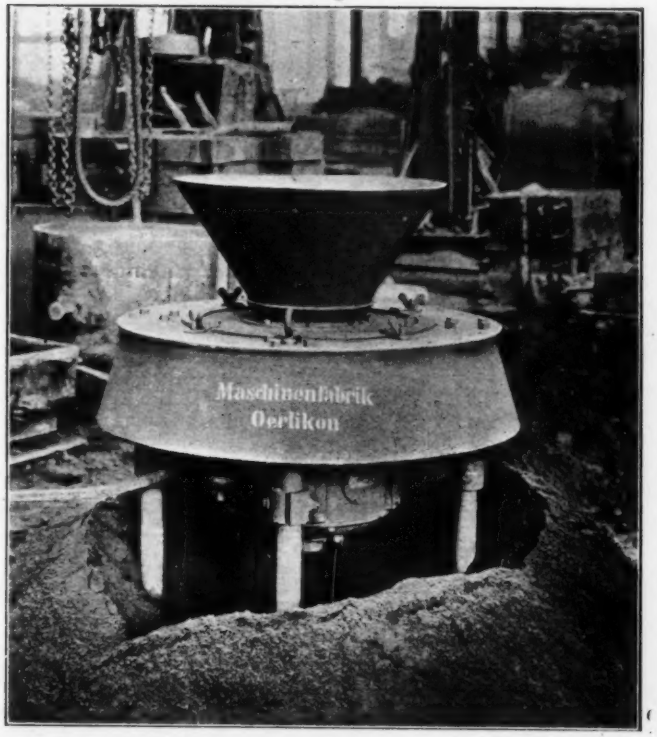


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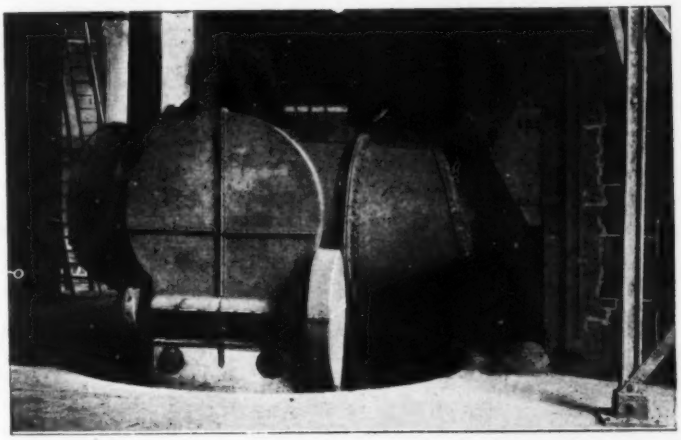

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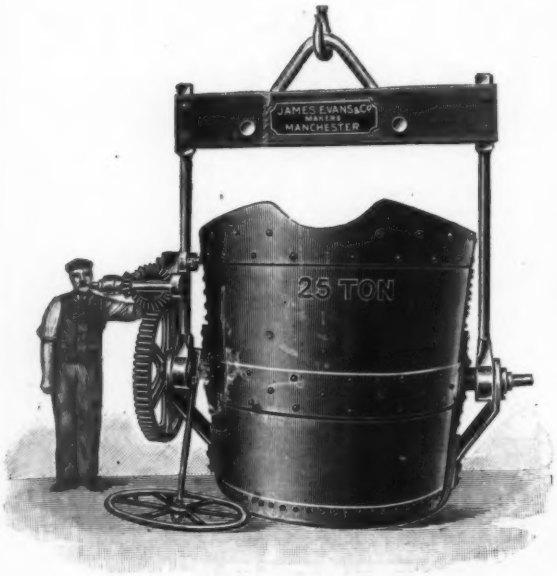


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# The Foundry Trade Journal
## AND PATTERN-MAKER.
THE OFFICIAL ORGAN OF THE BRITISH FOUNDRYMEN'S ASSOCIATION.

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## Forthcoming Events.

NOVEMBER 19.

*British Foundrymen's Association: London Branch.*—"Some Notes on a Tour of Continental Foundries," by H. G. Barrett (Erith).

NOVEMBER 20.

*British Foundrymen's Association: Scottish Branch.*—"Notes on Behaviour of Cast-iron in Structures," by Prof. Goodman.

NOVEMBER 26.

*British Foundrymen's Association: East Midlands Branch.*—"Gases and Gas Holes in Cast Iron," by R. Buchanan, F.R.S. (Birmingham).

NOVEMBER 27

*British Foundrymen's Association: Birmingham Branch.*—"Cast Malleable Iron and Cast Steel," by A. Harley, Coventry.

DECEMBER 4.

*British Foundrymen's Association: Lancashire Branch.*—Discussion on Foundry Problems; to be opened by C. Bickerton (Manchester).

## NOTES AND COMMENTS.

### Aluminium Castings in Die Moulds.

In view of the present demand for aluminium castings made in permanent or chill moulds, considerable interest is attached to a discussion of aluminium die casting contributed at the recent annual meeting of the American Foundrymen's Association by Mr. C. Pack. He contends that none of the die-casting alloys in general use (zinc, tin or lead base) exceed cast iron in tensile strength, and as die casting has economy as its first object, the cost of any die casting must be less than the combined cost of producing that casting in iron and machining to a finished product equivalent to a die casting. The cost of metal is therefore a vital consideration, since prohibitive prices for raw materials must exclude die casting from competition with other methods of production. In 1914 approximately 85 per cent. of the die castings produced were made from zinc alloys consisting of a minimum of 85 per cent. zinc, the other elements being tin and copper. But the recent exorbitant prices of zinc created a very difficult situation, and efforts were made to find a substitute. Aluminium, by reason of its price and general properties, suggested itself as a suitable metal, particularly since some work had already been accomplished in its application to die casting. Mr. Pack states that various claims of success in die casting such parts as automobile crank cases, transmission gears, etc., were found to be without foundation, and that the term die casting was misconstrued. "The practice of inserting iron parts in a sand mould at certain points to have machining," he says, "does not constitute die casting, by which is understood the process of pouring molten metal (under pressure) into a permanent metallic mould producing castings requiring little or no machining before assembling."

The alloy used in a process developed by The Doehler Die Casting Company is strictly aluminium copper, *i.e.*, it does not contain any tin, zinc or cadmium, which have been used experimentally in some aluminium alloys to aid their die-casting properties. This is claimed to be successful. The aluminium die casting, although a practical commercial proposition, cannot, according to Mr. Pack, economically replace the zinc-alloy die casting where the latter is satisfactory, despite the lower cost of the aluminium alloy for the same bulk. The cause for this, which is in fact the most serious drawback to the expansion of the industry, lies in the life of the dies. A die for zinc alloys will last almost indefinitely, whereas with aluminium alloys, the best die material obtainable to-day will not produce over 5,000 castings without "heat checking." When the high cost of producing dies is taken into consideration, it will readily be seen that it must add largely to the cost of the casting if a new die is to be made for every 5,000 castings.

While it is not worth disputing the definition given of die casting—whether casting without mechanical pressure such as is used in most apparatus would disqualify a process for the title, or whether casting in permanent moulds with pressure given by a runner head would come within the range—we are

inclined to think Mr. Pack is not quite right in assuming that the economy as compared with cast iron machined to a similar accuracy of finish is the test of the value of the process. There are many purposes for which the same metal would be used, whether die-cast or sand-cast, and it is the finish and accuracy of the duplicate castings which constitutes a great feature of the process. Of course, the relative cost is a very important feature, but in the case of aluminium there are many cases where it is a question of the relative costs of dies and sand moulds.

Much can be done by way of casting in permanent moulds of a suitable iron, without the fine finish of machined vanadium-steel dies and without the complicated apparatus used in the ordinary die-casting process. The secret of success in such work lies in the method of gating and running so as to get a good pressure and accommodate the shrinkage, and in the removal of any cores at the right moment. As each design presents its own peculiar problems in running, experience and experiment form the best guide. The melting of the metal is also an important feature. The readiness with which aluminium oxidises renders it difficult to prevent dross entering the mould. Therefore the metal should not be disturbed more than necessary, but the oxide which forms on the surface should be allowed to act as a protecting cover, only being skimmed back to allow access to the clean metal below. The metal also, should not be overheated, but if small work is being poured into dies or moulds the melting arrangements should be such as to keep a steady temperature, and for this purpose gas-firing is often advantageous. We have seen small aluminium castings being poured quite successfully into permanent moulds or dies by means of a dipper or ladle taking just the required quantity from a cauldron of molten metal on which the only protection was the oxide on the surface, this being skimmed back by the ladle just sufficiently to get at the clear metal.

### The National Effort.

While every section of the Nation is putting forward a great effort to meet the requirements of the war, there are in odd quarters little misunderstandings that require to be cleared, or they may operate detrimentally. For example, considerable misapprehension appears to exist as to the precise significance of the two badges which are issued to War Munition Volunteers. A communication from the Minister of Munitions to the Associated Ironmoulders, however, makes it clear that the enrolment badge serves as token that the recipient thereof has volunteered to put his services at the disposal of the Minister, who has power to move him to any part of the United Kingdom if he considers it desirable; and that, further, if the volunteer is not transferred by the Minister from his existing employment, it may be taken for granted that he is considered to be best serving his country by remaining where he is. The idea that the transfer badge signifies that a man is engaged on production of munitions, while the enrolment badge does not, is wholly false. The transfer badge is only issued to those men who have actually been transferred from their existing employment by the Minister of Munitions. In many cases it happens that a man who, at the time of his enrolment was not engaged on the production of munitions, has since been transferred by his firm, or of his own accord, to Government work. Unless this transfer has been effected by order of the Minister of Munitions, the man is not entitled to a transfer badge; but in the eyes of the authorities the enrolment badge is as honourable a possession as the transfer badge.

The Minister of Munitions also remarks that he has been informed that workmen employed in controlled establishments have been deterred in some cases from complying with the requirement of the Munitions of War Act that all rules, customs or practices tending to restrict production should be suspended in such establishments, by fear that any considerable increase in output might lead to a reduction of the piece rates paid to them. The Minister therefore calls attention to the fact that under the Act, no change in the rate of wages, salary, or other emoluments to any class of persons employed in a controlled establishment can be made without notice to the Minister, who may thereupon withhold his consent to the change proposed, subject to the power of either party to demand arbitration. The Minister also intimates that he is prepared to exercise his powers, if necessary, in order to prevent the reduction of piece rates as a consequence of the increase of output due to suspension of restrictions.

## American Foundrymen's Association.

### Report of the Secretary-Treasurer.

The following is extracted from the report presented at the annual meeting of the American Foundrymen's Association in September:—

Trade conditions, which were exceedingly unsatisfactory in the foundry industry during the past year, fortunately were not reflected in the growth in membership and the prestige of your Association. The membership on July 1 totalled 996, a gain of 213, or 28 per cent. in 11 months. The constitution and by-laws now provide for an admission fee of £2 for active and £1 for associate membership. Prior to May 1, this year, however, applications were received without the payment of the admission fees, and during the month of April, when a campaign for new members was carried on, 91 were enrolled, 43 active and 48 associate. By the affiliation of the paid-up membership of the Associated Foundry Foremen with the American Foundrymen's Association, 101 associate members were added. The resignations totalled only 31 during the year, or slightly over 3 per cent.; four members were dropped for non-payment of dues, and there were five deaths.

The number of delinquents at the end of the fiscal year was somewhat larger than in former years, due largely to depressed trade conditions, and the secretary-treasurer was authorised to carry their names on the books for a brief period. The extension of time thus granted for the payment of dues has resulted satisfactorily, and there is every indication that all of the accounts will be collected, leaving these delinquents in good standing and the total membership correspondingly increased thereby.

The Association is in better condition financially than at any time in its history. The appended financial statement shows a balance in the treasury of £223 on July 1, 1915, as compared with £15 on July 1, 1914. The total receipts from fees, subscriptions, sale of books, pamphlets and emblems, totalled £1,756, as compared with £1,278 from July 1, 1913, to July 1, 1914. The disbursements amounted to £1,548, against £1,263 the previous year. From the Associated Foundry Foremen was received £4, representing its balance in the treasury at the time of the affiliation of that organisation with the American Foundrymen's Association.

# Industrial Waste.*

By H. Sherburn.

The war in which we are now engaged is raising many problems and giving additional emphasis to others which were already before us. Some of these problems concern us especially as foundrymen and it occurs to me that a President's address is an appropriate means of calling attention to them.

One of the most striking features of the present conflict is the power of organisation which, both for war and industry, has been so largely developed by the Germans, especially during the last quarter of a century. We British have been repeatedly reproached of late years for our neglect of this power in industry. The capture of branch after branch of industry by the Germans from our very hands has scarcely had the effect of thoroughly arousing us from our state of self-satisfaction. The result of German organisation in the field of war is, no doubt, bringing these things again before us with added force and we shall be wise to meet the challenge fearlessly—even after long neglect—and take advantage of all the experience which recent happenings have given us.

Whilst we acknowledge, however, all the multiplied power which scientific organisation ensures, we should not overlook the fact it can only be got at a price. It will be for us to say—after careful consideration—whether the price is too high or whether some advantage of the better organisation may not be had without the servility of "Prussianism" which seems to have been the price paid by the great mass of people upon whom the working of great organisations depends. It will be our duty in the near future to find some happy means whereby we may utilise organisation so far as to still retain the independence and manhood of the craftsman and maintain the interest in his craft.

Another important problem we have before us is that of waste, and I wish to draw attention to some aspects of waste in foundry operations. The most important factor in the consideration of waste is that of human energy, physical and mental, and whilst one may be accused of misapplying philosophy, we are compelled, on close thinking, to recognise that the psychological aspect of the question should receive very full attention if the subject is to be adequately examined.

### Waste of Ability.

It is generally conceded that the standard of ability amongst moulders to-day—as craftsmen—is lower than was the case say a generation ago, despite the fact that more castings are now being produced than ever before, whilst the wider application of castings to human requirements, and the still greater possibilities ahead, demand a higher knowledge than previously obtained. The progress made, which is most pronounced from the point of view of output, has been chiefly obtained as a result of the application of mechanical methods to foundry practice. In contrast, however, we are developing a lower standard of mentality amongst the rank and file of the men who supply the human element in the process of castings production.

*Presidential Address before the Lancashire Branch of the British Foundrymen's Association.

The sure way of securing the best efforts of the human individual is by maintaining the interest in his occupation. The first function is to arouse interest and then, if possible, maintain it. Do our modern foundry methods tend in this direction? It will be generally agreed that except in the case of the jobbing foundries, the general practice does not stimulate more than a passing interest, and has practically no attracting or "drawing" power whatever.

Let us briefly consider the main causes of waste in this direction. It must be realised that to no single factor can be assigned the full responsibility for this state of affairs. The responsibility lies between the man, the foreman and the general organisation.

### The Training Problem.

The main concern of the management is to keep down the cost of production, especially if engaged in a competitive industry which probably means cut prices coupled with heavy selling and establishment charges. The management often fails, however, to appreciate the point of view of the superintendent and the worker, whilst so-called cheap labour often has an attractive sound largely as a result of failure to appreciate the industrial outlook. The foundry superintendent of to-day need not necessarily be a practical moulder, his first qualification must be ability to get the work through. There is a vast difference between doing work and seeing that it is done; the person who combines both qualities, however, is much more effective than the specialist in either direction. Incidentally the foundry superintendent may be a greater victim to a rigid system than those who work under his direction. His work must be mapped out for each day, if he has any idea of keeping ahead of it, and thus there is a tendency to direct all effort upon mechanical and routine lines. He makes sure of his castings by specialising his work, giving certain work to certain individuals and keeping the job with them.

Under such conditions, however, the man in charge has always an anxious time in considering how to get difficult work through. His system specialises his men and he feels that some jobs can only be made by certain men and if they are absent or otherwise engaged he is involved in difficulty when extraordinary work comes along, and often finds himself compelled to give the work to men who will be almost sure to produce a number of wasters before any good castings come through. In other words, he is compelled to *train grown men* instead of apprentices, a difficult, costly and unsatisfactory arrangement. Were he in command of a competent staff he would have no qualms as to whom he could trust with this or that job, whilst there would be more opportunity to stimulate the interest of the moulder by reason of the variety of work which could be safely entrusted to him.

The British Foundrymen's Association, in dealing with the apprenticeship problem in regard to foundries, recognises the difficulty, but whether the methods they suggest will prove effective remain to be seen. The chief danger is that the training of a few individuals may be more thoroughly accomplished whilst the state of the wider class will be little im-

proved. Ambitious individuals can generally look after themselves, but it is the larger body of workers that is in most need of fuller development. The tendency is to train select juniors, using the possibilities of becoming foremen or managers as a bait, instead of encouraging larger numbers to become craftsmen. If the general standard is raised there will be a still higher test imposed upon those who aspire to management.

### Mechanical Methods.

Singular though it may seem, the adoption of mechanical methods to foundry practice has complicated the question and to some extent, at least, this is due to the character and design of the appliances devised. The object of machine designers seems to have been to eliminate skill and multiply "donkey work" in moulding operations. Hand ramming has been reduced, the skill of pattern drawing has been eliminated, and in their place the moulder has been given more sand to shovel, more flasks with their multiplicity of jackets and weights to pull about and more metal to pour. He may also be furnished with a pneumatic rammer with which to "steady" his nerves! To these doubtful advantages is added the knowledge that a labourer can perform the work almost equally well, provided he has the necessary physique, although he will demand moulder's wages and often get more, as soon as he has got the run of the job, without having the other qualifications of a moulder. Thus we have the striking anomaly of physical labour being better recognised than the work of the skilled craftsman.

The results of the present system recall some of the advantages of the discarded indenture method of apprenticeship. It is common experience that when a youth shows some ability he leaves his shop for that of a neighbouring firm, for the sake of a shilling or two more per week. It matters little whether he is going to learn anything more as a result of the change; the immediate financial advantage carries him away, and he makes a move which he often regrets later.

This is one of the problems which make the employer unwilling to move in the matter of increased training facilities, the result of his efforts being that his good youths leave as they are becoming useful, whilst those boys of less promise stay on. A solution will be in sight when it is realised that economic considerations constitute but one aspect of the question and that moderate wages in the earlier years, together with good experience, are much more valuable than high pay for work that calls for little more than tough muscles.

The inadequate facilities for the technical education of young moulders is eloquent testimony to the failure to interest the young men in the industry. If the demand were made it would very quickly be met by the education authorities. One of the first steps toward an improvement is that wider variation in work should be given to the apprentices, even at some little sacrifice in production; the immediate loss would be more than balanced at a later period. This matter is of course largely in the hands of the foundry foreman, whose chief weakness is a narrow outlook.

Isolated cases may be cited where imagination and breadth of vision have been brought to bear upon industrial methods and the result with good management has been, not only equal economy in production, but a wider development of craftsmanship. It will have to be realised, however, by those in authority, that positions of management are not easy berths, but carry with them responsibility for the comfort of the workers, much of which can often be discharged with no further expense than a little sympathetic forethought.

It is for everyone concerned in management to quietly consider his methods, and the time spent in this reflection will, if subsequently acted upon, be more than repaid by the better work, less wear and tear of patterns and plant as a result of greater interest taken in the work by the foundry staff. There will be freedom from anxiety in the knowledge that the staff is competent to handle all the work that they are called upon to produce.

If the foundry is to take its deserved place in the scheme of industry, we must harness and develop the intellect at the same time as the physique of the craftsman. The combined experience properly classified, of an intelligent staff, added to the knowledge possessed by the management, should tend more rapidly to efficiency than all the efforts of one or two individuals, no matter how clever those personages may be.

So much for the human side. Let us now pass on to the consideration of other sources of waste, taking the question of iron as of greatest importance. There are two main directions in which wastage of iron may proceed:—(1) By the purchase of expensive brands unnecessarily; (2) by excessive losses in melting.

### Expensive Irons.

On the first point there will be considerable difference of opinion as to what scope there is for saving. It is realised that in some cases the foundry foreman is often so beaten down in price of finished castings that he is compelled to procure the cheapest foundry irons marketed. The surprisingly good results attained under these conditions is often remarkable. On the other hand, we find that many foundries are producing castings at very good prices and in which many of the most expensive brands of pig-iron are used. There is also the other condition where the iron is bought for the foundry without consulting the man in charge, who has then to make the best of what is given to him. It will be obvious that this latter method of securing supplies cannot be efficient, unless as is sometimes, but very rarely, the case, the foundry foreman has not much knowledge of his materials and the buyer has.

It is usual when foundries are working on remunerative work that standard mixtures of metal, based upon experience, are obtained. An inherent conservatism often prevents further experiment, and unless the castings begin to develop faults it is probable that nothing will induce the man in charge to reconsider his mixture, even with a view to lowering the cost thereof. The use of high-quality irons is in many cases largely a matter of sentiment and there is no doubt that they are often used when cheaper brands would be equally satisfactory. The term "high-quality iron" is a strictly relative one, depending entirely upon what constitutes the common iron of the particular district. It is quite conceivable that in a district where highly-phosphoric irons are rare that class of metal which we regard as common iron would be considered of high quality.

Here, therefore, we have a possible source of waste if expensive irons are used unnecessarily, and it is for every founder, if he knows his work, to reflect upon the cost of his various mixtures and consider whether cheaper types of pig cannot be more widely used, even to the entire exclusion of some of the more expensive brands now largely employed in foundry practice. Of course, if the foundryman is not conversant with the distinctive features of the various brands of iron beyond the very broad terms of strong, soft, chilling, fluid, etc., he cannot hope

to adequately deal with the problem. Every founder worthy of the name (at all events in charge) should have full knowledge of the distinctive features of the respective types.

### Knowledge of Suitable Irons.

It is not merely necessary to know these differences, but the ability to compare them in the light of their cost should be possessed. The information thus obtained will show whether the cost and quality are comparable. If guided by analysis it will often be possible to obtain similar combinations in alternative ways.

Further, we find certain brands of iron commanding high prices whose equivalent may be obtained at a considerably cheaper rate by the study of analysis and the subsequent mixing of large proportions of cheap brands with small amounts of a better type. Again there is considerable variation in the price of identical irons. The law of supply and demand seems to offer the explanation for this anomaly and for this reason certain brands obtain a reputation based upon their higher selling price which may be entirely erroneous.

Considerable waste is also caused from time to time owing to the lack of uniformity in foundry irons. It has been pointed out at various times in the past that owing to the iron and steel makers demanding iron to analysis, the faulty iron which is produced at times finds its way to the foundries, where the materials are much more rarely submitted to analysis. This condition will continue to obtain until some organised effort is put forward by the founding industry to alter it. Pending the attainment of this happy position the founder is concerned in finding a palliative. By using a number of the standard common brands of iron in the mixtures instead of keeping to one or two, it is possible to reduce the chance of trouble through lack of uniformity. Thus if one brand goes off in quality its influence upon the mixture will not be so serious if it is only one of a number as would be the case if only one or two brands were used in the charge.

### Classification of Irons.

The classification of foundry irons into several broad groups is a work which might well be taken up by the British Foundrymen's Association. Such an investigation need not involve very much work and its unbiassed results would be of much value to foundry managers and others interested in foundry iron. The statement of the distinctive qualities of the various standard brands and their influence upon foundry mixtures would be very helpful to those who have not had the time or opportunity to thoroughly study the question.

Faulty design is doubtless largely responsible for the use of expensive irons. In this case they are used in order to withstand the strains set up as a result of irregularities of shape and thickness. The efforts of the foundryman should never be relaxed in combating this, and the designer should be gradually brought to appreciate the problems of the cooling of molten metal. Uniformity of cooling and its influence upon regularity of crystallisation are intimately related to the ultimate cost of castings and it has been stated and restated, and practically experienced by many of us, that the strength of castings is more dependent upon proper crystal structure of the metal than upon the chemical composition of the metal itself, within certain broad limits. Experience in light-castings practice emphasises the point very strongly. The position of runners in this class of work often means all the difference between sound castings and those which have such internal strains and stresses that the slightest shock will break them, if indeed they do not fracture themselves in cooling.

### Iron Losses in Melting.

The other main source of iron loss, that during melting, is perhaps a little more complicated. In the first place it is evident that a considerable amount of material enters the cupola apart from the metal which runs out in the molten state and carbon of the fuel which is converted into gases, with the evolution of heat, and passes off as such. There is the sand on the iron, the ash of the fuel, which varies in amount according to the quality of coke used, and also the impurities of the flux.

There are many foundrymen who do not realise the chemical reactions taking place in the cupola. In fact, it may be said that very little reliable information is available respecting the thermo-chemistry of iron melting in blast furnaces. Experience has, however, revealed certain facts which, if considered from a chemical point of view, will improve our practice. We know, for instance, that the process of melting iron under foundry conditions is accompanied by the production of a certain proportion of slag. The reason for slag formation and the different types of slag that may be produced under different conditions may not, however, enter our calculations, and so long as the iron comes down fairly satisfactorily the question of iron losses in the slag is generally ignored.

Some foundries require steady melting throughout a defined period, others may require large quantities of iron at intervals, in one case very hot iron may be required throughout the blow, whilst another may want hot iron at one time and duller metal at another and so the cases might be multiplied. Efficiency does not therefore entirely consist in obtaining the largest melt of iron per unit of fuel; the more effective calculation is based upon the proportion of coke consumed to the weight of sound castings produced.

### Iron Losses in Slag.

Reverting to the question of fluxing, it is remarkable to note the difference of opinion in this matter. I have known foundries where it was considered economical to melt iron without the use of fluxes. It is conceivable that blast furnaces making pig-iron can operate without the addition of fluxes in cases where the ore is of such a character as to contain the necessary proportions of acid and basic materials to produce a satisfactory slag free from iron. It is, however, difficult to understand how the simple melting of iron without the addition of fluxes can be regarded as a economical operation in view of the impurities introduced in the process. It is perhaps unfortunate that so little data is available upon this subject. The foreign matter introduced accidentally into the cupola, which is chiefly silica or sand, is converted into slag at the furnace temperature by combining with bases. If the base lime forms part of the charge the slag will be a silicate of lime. If the lime be in excess the free lime will attack the lining of the cupola and form further slag. Should there be a shortage of lime the excess of silica will combine with some of the iron to form a silicate-of-iron slag. Hence the loss of iron in this direction. The cost of lime being but a fraction of that of iron, it is more economical to produce slags high in lime than those in which iron is the principal base. The amount of lime required will have to be determined for each case individually, depending upon the purity of the materials used. When lime is used for fluxing (and

notwithstanding the fancy-named fluxes on the market with prices to correspond, there is no better material of its kind for general use), it is preferable to use the best qualities, which are more free from impurity in the form of silica. It will be obvious that the introduction of further silica not only reduces the effectve power of the lime, but also causes the expenditure of fuel in heating the materials to the working temperature of the furnace.

It is desirable to use limestone in the form of chippings, as owing to the removal of the slag being fairly rapid the contact of the materials is not very prolonged; the chance of the whole of the lime combining is therefore much greater than when used in the larger form.

In the matter of fuel we have definite specifications in numerous text books. These definitions do not, however, always prove reliable and experiments with different furnaces have shown that softer cokes answer much better than the extremely hard ones under certain conditions, whilst under other furnace conditions the reverse has been experienced. Whilst therefore it is possible and desirable that something approaching uniformity in cupola practice should be obtained, the final adjustment of conditions is entirely dependent upon the local requirements, and a broad generalisation without giving them full consideration will not attain efficiency in melting practice.

### Runners.

In repetition work considerable amounts of iron may be unnecessarily melted owing to runners being too heavy and large. In a large shop the reduction of an ounce or two in the weight of runners will materially reduce the amount of scrap produced. As a possible source of saving, therefore, the design and position of runners is of no little importance.

### Impure Materials.

Some of the materials used in conjunction with sand in foundry operations are consumed in comparatively large quantities; and may be supplied in a very impure state if the user does not investigate them very closely; thus another possible source of waste opens. In the case of coal-dust, blacking, and resin, we can reassure ourselves by means of simple combustion tests without the use of any special apparatus. All that is necessary is some kind of vessel in which a small definite quantity may be burned and the residue, if any, be retained. It is obvious that the best samples will contain the least proportion of ash, and by comparison of samples from time to time against one of known good quality, a very fair idea will be obtained with little cost or trouble. With regard to core-gum, comparisons of solubility in water together with combustion tests would provide a useful indication of their quality in the absence of special testing apparatus, in addition to observations made in actual use. These suggestions are intended mainly for the foundryman who is not equipped with a laboratory for chemical analysis; many have, of course, ample means of testing these materials in a more delicate manner.

It is illuminating to peruse many of the advertisements, especially those of American origin, relating to core-compounds, parting compounds and substances which are claimed to convert blowholes into the soundest part of the castings. Materials with strange names, which are sometimes annoying examples of simplified spelling, are offered, all with the common object of ameliorating the hard lot of the foundryman. It is remarkable that though the vendors of these articles dilate upon the science of founding they do not indicate the composition of the materials that are claimed to give such notable results. If the foundryman in difficulty tries one of these remedies and obtains satisfaction he will probably continue to use it, but will pay well for the privilege unless he finds out its true composition and obtains it from another source at a more equitable price. We may reasonably hope, however, that the introduction of chemical analysis will clear the air with regard to many of these materials.

There is plenty of scope for real invention in connection with the foundry business. It should, however, be impossible for anyone to obtain high prices for common articles, offered under meaningless names, merely because they may not have been previously applied to a particular industry. Further, as all information is obtained by proceeding from the known to the unknown, so the fuller knowledge of his materials would give the foundryman a wider basis upon which to build his further investigations. Science will not tolerate secrecy in the common materials of industry. The foundryman should insist upon having the fullest information concerning the materials upon which the success of his work largely depends.

### Application of Science.

Continued progress in the craft of founding metals depends upon the adoption of scientific principles. This does not mean the introduction of a new and mysterious method of working; in many cases it may mean some modification of practice, and in others it will amplify present methods. Many of us are apt to misunderstand the meaning of the word science. We associate its application to foundry practice with the introduction of chemists having no actual foundry knowledge. There is equal danger of the practical man and the theoretical man being unscientific.

The practical man is guided by his experience, which is based upon observation. He is scientific if he observes accurately and his practice follows natural and economic laws. It may be that intuition prompts certain operations, but if they follow the above laws they are scientific. The practical man is unscientific when he does not take an active interest in his work, or if he allows preconceived ideas and personal prejudice to obscure his judgment.

On the other hand, the theoretical man is liable to be unscientific in other directions. He is chiefly guided in his investigations by his theoretical knowledge of chemical and physical laws, information on which is as yet in a very incomplete state. He may be led astray in his deductions by failing to consider some condition which has not revealed itself to him, and could not therefore be taken into account. He is also likely to be a victim to his own preconceived ideas. Thus the liability to become unscientific does not lie all one way or another. Sympathetic co-operation will, however, make the way much clearer for both workers.

### Discussion.

Mr. R. W. Kenyon said that Mr. Sherburn's address was a proof of the advantage of the scientific course of study he had followed in bygone years. To some of them it was a source of envy to notice the great privileges which the rising generation now had put within their reach, and of soreness to feel that they who were older had been deprived of them. Mr. Sherburn had gone very closely into his subject, and had given them many hints which he (the speaker) would try to develop in the near future. There was no question that the Germans had been much more thorough than ourselves in their scientific training of the young. He wondered whether it would be possible to set up in England an institution such as they

had in Germany, in which there were two hundred of the best trained chemists engaged in research work, doing nothing else but trying to discover new methods and combinations.

MR. SIMKISS said it was surprising to find how many men there were who having spent some years in a foundry, had elected to go to other jobs. Physical labour, Mr. Sherburn said, was now being better recognised than the work of the skilled craftsman; more than brains; but the foundryman had never been asked to deal with more difficult work than now.

MR. W. H. SHERBURN said the remark that the Germans had only gained the results of their organisation at a price, touched his mind very closely. Some of them no doubt would remember that Darwin expressed his regret that having run his mind in one groove so long, he had lost the power of feeling interest in any other. That was the case with the Germans; they had got their results at a price—the loss of the ideas of beauty and appreciation in other directions. It was a great price to pay, and it was for us to try and obtain the highest organisation we could, but still to remember that man was after all more than organisation, and that he was here to live and get some happiness out of life, and not only to make castings.

The meeting concluded with a hearty vote of thanks to Mr. H. Sherburn for his address.

## British Foundrymen's Association.

### SCOTTISH BRANCH.

The first meeting of the 1915-1916 Session of the Scottish Branch of the British Foundrymen's Association was held at Glasgow on October 16. The new President, Mr. Matthew Riddell, on behalf of the Council and the members of the Association, thanked the retiring President, Prof. Campion, for his services to the Association during the past two years, and assured him that the members appreciated to the highest degree the valuable work which he had accomplished during his term of office as President. Mr. Riddell then referred to the syllabus of lectures for the Session, which is as follows:—November 20, 1915, "Notes on Behaviour of Cast Iron in Structures," by Professor Goodman; December 11, Open Meeting; January 15, 1916, Presidential Address, by Mr. M. Riddell; February 12, "Notes on Cupola Practice," by Mr. R. B. Robinson; March 4, "The Value of Science in the Workshop," by Mr. W. H. Cathcart; March 25, Annual Business Meeting.

The President intimated that in the ordinary course of events he should have delivered his Presidential address at this meeting, but he had postponed it in favour of a Paper by Mr. F. Naylor on "Artificially Bonded Cores."

#### Artificially Bonded Cores.

MR. NAYLOR, at the outset, referred to the different kinds of binders used in core work, and the difficulties to be met with in working with these different materials. The great advantage which oil-bonded cores had over those bonded with clay was that they did not absorb any moisture from the mould, the mould could therefore be cored and closed at any time without fear of capillary action. An oil-bonded core was impervious to dampness; the cores could if necessary be made and dried weeks before they were required; they would be as dry after that period as when they left the stove. Another advantage which oil-bonded cores had, was strength. (The lecturer to prove the strength of an oil-bonded core, took a hollow cylindrical core about 4 in. outside diameter by 2¼ in. inside diameter, and placed it under a pressure of about 2 cwts. without damaging the core in any way). Owing to the strength possessed by such cores wiring and core irons were seldom required.

A peculiar thing about an oil-bonded core was that its strength did not detract from its openness or porosity, and only in very exceptional cases did oil-bonded cores require venting. An oil-bonded core was also a core with high refractory qualities, and it had also the important qualification that it was readily removed from the cold casting, to which it gave a clean and smooth skin. It would be seen that such a core had many of the qualifications which a perfect core should possess.

The speaker next referred to the mixing of the material and the proportion of oil to sand. He stated that no better oil could be obtained for binding cores than linseed oil, the physical properties of this oil made it admirable as a bond with sand for cores. It was equally suitable in its raw or boiled state. The best sand to use was ordinary seashore sand, and the proportions should be about four shovelfuls of sea sand to one pint of linseed oil, with sufficient water to give it the required consistency. The mixture should be passed twice through a ¼-in. mesh riddle, well turned over and trampled with the feet. For mixing large quantities it was advantageous to have the sand passed through a sand mixer.

The cores should be dried at a temperature from 450 to 500 deg. Fahr., for about three to four hours. If the temperature of 500 deg. were exceeded, the oil separated from the sand and the cores became useless. In the absence of a special stove, an ordinary drying stove could be used, but the oil-bonded cores should be placed in the coolest part of the stove, *i.e.*, near the floor. One of the disadvantages of oil-bonded cores was the difficulty of handling the core in its green state; with flat cores there was no trouble, but with cylindrical, spherical, or similar shaped cores there was difficulty in handling; such cores require to be dried in a vessel or box similar in shape to one of the halves of the core box. The boxes in which the cores were made should be well oiled to prevent the sand adhering to the sides of the box.

After the lecture a discussion took place in which a number of members, including Mr. Mayer, President of the British Foundrymen's Association, took part, and the meeting concluded with a hearty vote of thanks to the lecturer for his Paper.

### EAST MIDLAND BRANCH.

We have received from Mr. H. Pemberton, 15, Wolfa Street, Derby, honorary secretary of the recently-formed East Midland Branch of the British Foundrymen's Association, the programme for the remaining meetings of the 1915-16 session:—

November 26.—"Gases, and Gas Holes in Cast Iron," by R. Buchanan, F.R.S.A. (Birmingham).

December 11.—"Carbon in Iron," by Professor T. Turner, M.Sc., A.R.S.M., F.I.C. (Birmingham University).

January 28, 1916.—"Brasses and Bronzes," by H. L. Reason (Birmingham).

February 12.—"The Making of Plaster and Stucco Patterns" (with practical demonstrations), by C. Heggie (Birmingham).

The October, December, and February meetings will be held in the Technical College, Green Lane, Derby, at 7 p.m. prompt. The November and January meetings will be held in connection with the Leicester Society of Engineers, at 5, St. Martin's Lane, Leicester, at 8 p.m. prompt.

# A Large Bessemer Foundry.

Writing in a contemporary* Mr. Edwin F. Cone describes the plant of the Reading Steel Casting Company, Reading, Pa., U.S.A. Commencing in 1906 with a small foundry, formerly the Brylgon Steel Casting Company, having but one converter, the present management has seen the plant grow to four times its former size in melting capacity and eight times in floor space and sales. Though the new construction has been gradually added to the old, the necessity for an orderly progression in foundry manipulation has not been overlooked. The result is a unit ensuring fairly satisfactory conditions as compared with the possibilities of an entirely new plant. With an output of 600 tons of finished castings per month, averaging 30 lbs. to the casting, and a possible production of 700 tons, this plant, with its four 2-ton converters, can equal the tonnage output of some of the smaller open-hearth foundries.

Three features are prominent in this foundry, the moulding facilities, the production and manipulation of the steel and the heat treatment and finishing of the castings.

Very small castings, made in large quantities daily, are the chief work of such a foundry. In the average small foundry many of these are made in snap flasks, in which they remain until poured. This involves the provision and handling of hundreds of such flasks. The Reading Steel Casting Company approached this problem in a different way. In a large space devoted solely to this class of work, on a concrete-covered floor provided throughout the plant, a battery of moulding machines and some bench moulders turn out hundreds of moulds in snap flasks. Instead of leaving the finished mould in its flask, each one, removed from the flask, is placed upon a rack carrying several moulds on steel plates. By means of a monorail crane system each rack of snap moulds is transported to specially-constructed oven cars.

Thorough drying of these small moulds in two ovens is a feature, thus eliminating the uncertainty resulting from the pouring of such castings in green sand. The moulds are then bedded in on the dry floor in front of the ovens where they are poured and knocked out.

As shown by the plan of the plant herewith, there is a larger moulding floor of concrete, 68 ft. by 240 ft., which is served by two 10-ton travelling cranes and which has two drying ovens of a capacity of ten cars each. Each oven has two tracks and each track carries five cars, a total of 20 cars capacity. It has one jolt moulding machine with a capacity of 5,000 lbs., served by an electric jib crane. Six pneumatic sand rammers are also a part of the equipment. Here the larger castings are moulded and prepared with the usual flask equipment.

The core department, located conveniently at one side of the main dry floor in a bay, has a special continuous core oven, there being only one other like it in operation. The illustration of this department shows this oven. It contains 48 sliding compartments, each one of which can be opened independently for the placing in or removing of cores without interrupting the drying of other cores. It is fired over a pit with coke and hard coal and is operated continuously.

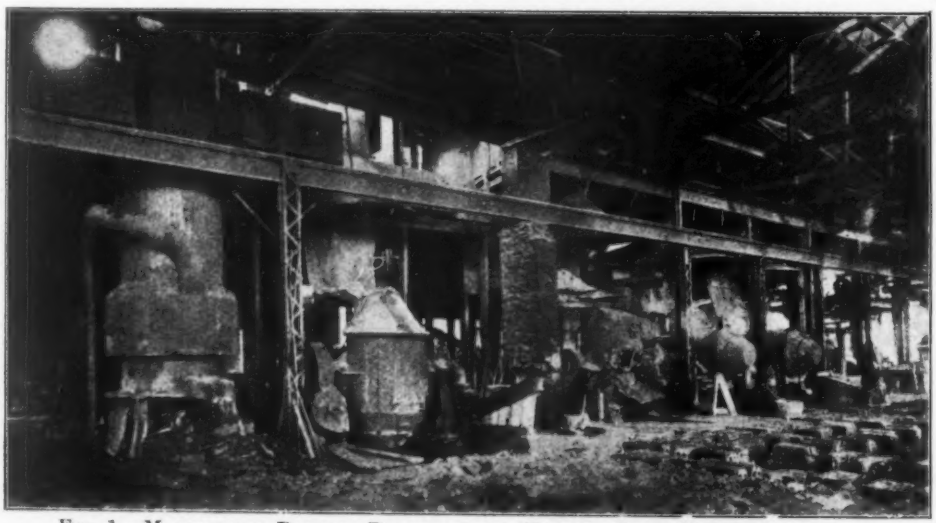


FIG. 1.—MELTING AND BLOWING DEPARTMENT OF READING STEEL CASTING COMPANY.

With the equipment and facilities described, the Company can pour 1,400 tons of finished steel per month. Allowing an average yield of 50 per cent., 700 tons of finished castings is the possible output. This means blowing and pouring 54 tons per day in a month of 26 working days, nearly the equal of an open-hearth foundry having one 20-ton furnace. All this metal, however, is produced and poured in from six to seven hours in the day time, no night shift being employed.

The equipment consists of four 2-ton converters, originally of the Tropenas type, but so altered and improved that the Company considers them its own

* "The Iron Age."

design. Besides the converters there is one large cupola as well as a smaller one at the opposite end of the row, for pre-melting the additions of ferro-silicon, ferro-manganese, etc. Fig. 1 shows the four converters, the cupola and the oil-heating arrangement for the cupola ladle. The converters are operated in batteries of two, one being blown while the metal is removed from the other; a third converter is in the meantime being repaired. Every 20 minutes, 5,000 lbs. of metal can be poured into moulds, and as a consequence no time is lost as to small castings. Bottom-pour ladles are the rule, over 92 per cent. of the castings being poured this way. Each ladle is pre-heated with oil, and they are handled just after pouring by means of a small car, made of a ring mounted on low wheels, on which the ladle is placed by the large crane, it being then easily rolled to a cleaning floor for proper treatment in preparation for a new heat, eliminating further crane handling.

No heats are made without recarburisation, etc., with pre-melted alloys, except special ones for electrical purposes or those specified under 0.10 per cent. carbon, without manganese or silicon. These are taken from the converters as blown, and enough aluminium added to remove oxides and ensure solid metal. A small cupola is used solely for pre-melting. Here proper amounts of ferro-silicon, pig-iron and ferro-manganese are melted together, tapped into a small ladle and poured into the finished blown steel in the converter. Since the threatened scarcity and high price of ferro-manganese, the use of high-grade spiegeleisen as a substitute has been inaugurated with marked success. This is melted with ferro-silicon, furnishing not only the necessary manganese but also the carbon usually obtained from the pig-iron.

As regards the metal, steel scrap up to 50 to 60 per cent. of the charge is used together with high-grade coke and low-phosphorus, high-silicon pig-iron. It contains about 1 per cent. of copper and so do the castings made from it. It has been believed, and is still in many quarters, that over 0.25 to 0.50 per cent. of copper in castings is a decided detriment to their physical and other properties—especially where the sulphur content is high. The Reading Steel Casting Company has found that with a content of 1 per cent. copper and the sulphur ranging from 0.045 to 0.060 per cent., physical results after proper heat treatment are obtained which equal and surpass those from many open-hearth and other steels free, or nearly free, from copper and lower in sulphur. The physical results of some of this steel are given in another part of this article.

Of prime importance is a proper annealing of steel castings. Where the shape and class of casting will permit it, quick cooling from just above the recalescence point will produce the best physical results and the toughest metal. The continuous annealer, into which a car of "green" castings can be pushed as one with treated castings is pulled out into the air, insures this heat treatment. Two annealers make up the heat-treating department at Reading. One

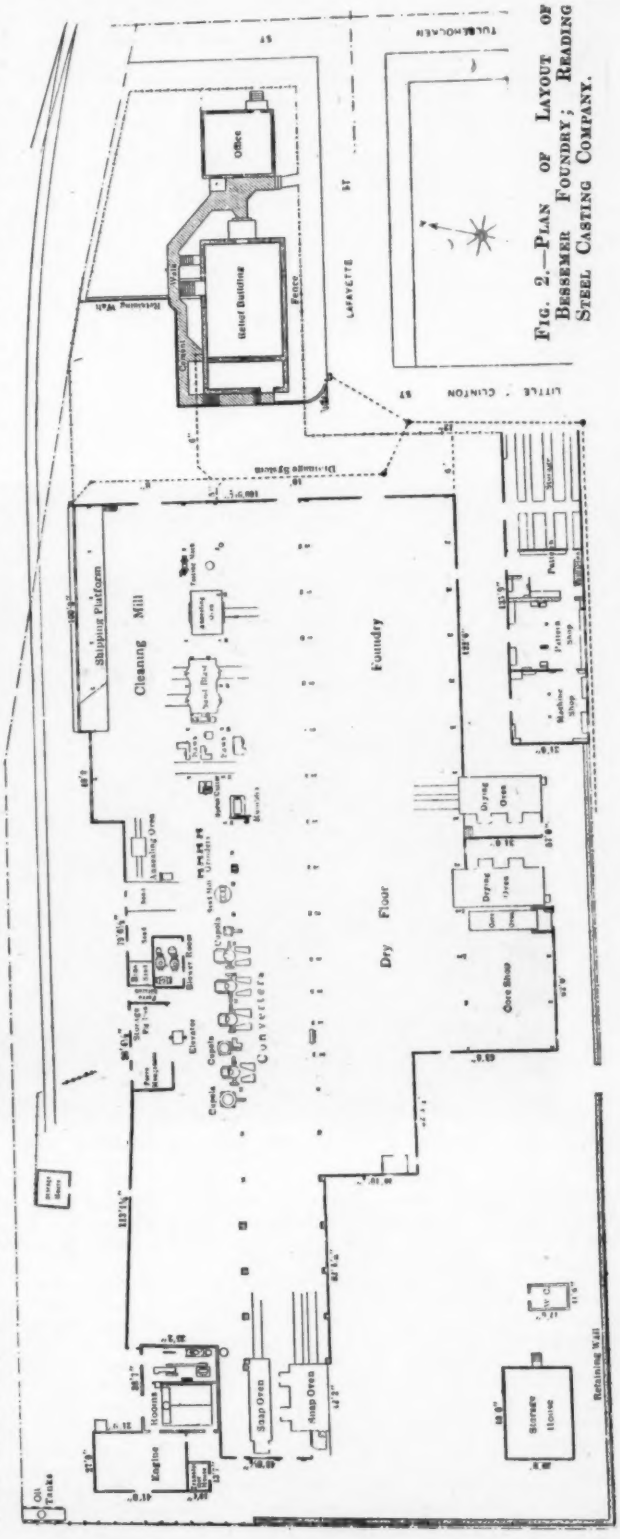



FIG. 2.—PLAN OF LAYOUT OF BESSEMER FOUNDRY; READING STEEL CASTING COMPANY.

is a small annealer for small castings of special heats. It is oil-fired and equipped with two cars, ensuring continuous operation. The other is a larger one, coal-fired, also equipped with two cars for continuous operation. It is open at both ends so that castings go through the furnace from one department to the other. The table of physical tests given herewith is evidence of the effectiveness of the heat treatment. The elastic ratio and ductility are noteworthy.

*Physical Tests of Annealed Converter Steel Castings*

| Tensile strength. | Elastic limit. | Elongation in 2 in. | Reduction of area. | Fracture. | Elastic ratio. |
|---|---|---|---|---|---|
| Lbs. per sq. in. | Lbs. per sq in. | Per cent. | Per cent. | | Per cent. |
| 68,900 | 39,500 | 33.0 | 52.1 | ½ cup | 57.3 |
| 70,700 | 45,000 | 33.0 | 55.0 | ½ cup | 63.6 |
| 71,000 | 44,500 | 33.0 | 55.0 | cup | 62.6 |
| 70,200 | 43,350 | 34.0 | 54.7 | cup | 61.7 |
| 69,800 | 42,750 | 34.0 | 54.7 | cup | 61.2 |
| 71,900 | 44,000 | 34.0 | 54.1 | ½ cup | 61.1 |
| 72,000 | 44,000 | 33.0 | 54.4 | cup | 62.5 |
| 68,500 | 40,000 | 33.0 | 53.3 | ½ cup | 58.3 |
| 71,500 | 43,500 | 33.5 | 53.3 | cup | 60.8 |
| 70,000 | 41,100 | 35.0 | 53.3 | ½ cup | 58.7 |
| 70,500 | 42,000 | 32.0 | 53.3 | cup | 59.6 |
| 70,250 | 43,050 | 35.0 | 54.7 | ½ cup | 61.2 |

The product of this foundry is plain carbon steels except for the copper content of practically 1 per cent. They range in carbon from 0.25 to 0.33, in manganese from 0.50 to 0.75, in silicon from 0.25 to 0.30, in sulphur from 0.045 to 0.060, and in phosphorus from 0.035 to 0.045 per cent. The management claim that a trial on an extensive scale of non-copper bearing pig-iron resulted in satisfactory evidence of the beneficial effect of the copper.

Two other factors, however, enter into this question:—1. The method of casting test bars. 2. The method of heat treatment. The test bars, about 1 in. by 1 in., are cast on the bottom of a solid block of steel, 2 in. thick. This insures solid, dense metal and a speed of cooling resulting in an initial structure free from ingotism. All castings are annealed unless the Company is instructed to the contrary. They are sand-blasted or rumbled. While the cleaning department has three cold-saws, use of these is abandoned whenever possible. A large sprue cutter or the oxy-acetylene torch removes most of the small gates, heads and sprues. For taking off lumps or rough spots mounted swing grinders are particularly efficient, and these are mounted on wheels so that they can be operated in practically any part of the shop.

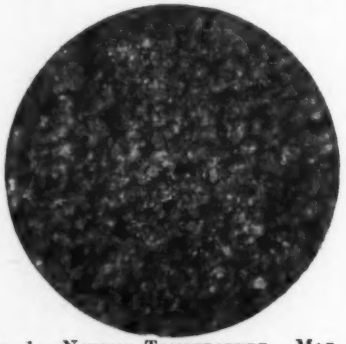
FIG. 3.—VIEW OF CORE ROOM OF READING STEEL CASTING COMPANY'S FOUNDRY.

**A "SPECKLED" FINISH ON PLATED GOODS.**—According to H. E. Willmore, in "The Metal Record," to obtain a "speckled" finish on silver-plated or copper-plated goods, after being plated the goods are oxidised in a liver-of-sulphur solution; then a solution of potassium cyanide is made, consisting of about 1 oz. of potassium cyanide to the quart of water, some coarse sawdust—preferably a hardwood—is saturated with this solution, and then sprinkled on the oxidised surface and allowed to remain but a few minutes, when it will have removed the oxide wherever the sawdust has come in contact with it. To remove the sawdust, as much as possible should be shaken from the article, and to remove the remainder the work is held under a faucet of running water. After removing the sawdust the work is dried and scratch-brushed with a soft, worn steel brush and then lacquered. The above process can be reversed, and, instead of first oxidising the article, the sawdust is moistened with the liver-of-sulphur solution and the work oxidised in spots by this means, giving an altogether different finish from that obtained by the first method.

# Tests of Foundry Sands.

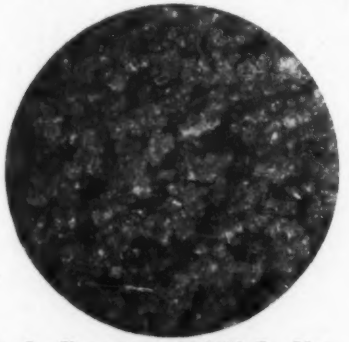
By Algernon Lewin Curtis, M.E.

*Material Tested* :—**IRISH SAND (Belfast)**. *Weight of Sample* :—100 grammes. *Colour and Description* :—Light brick red. *Consistency* :—Medium-Strong, Fine. *Surface Factor or Size* (Grammes per cent.).—Retained on 50 sieve, 1.500 ; Retained on 100 sieve, 42.320 ; Sieved through a 100 sieve, 56.180. *Water Required for Maximum Cohesiveness when Dried 1 hour at 100 deg. cent.* :—4.50 C.C. per cent. *Venting Capacity of 1 Cub. In. when Mixed 400 Times with 4.50 per cent. Water and Rammed at a Pressure of 25 lbs. per Sq. in.* :—About 3.50 lbs. air pressure. *Plate* :—Wellington-Ward "Anti-Screen." *Objective* :—1" Watson.



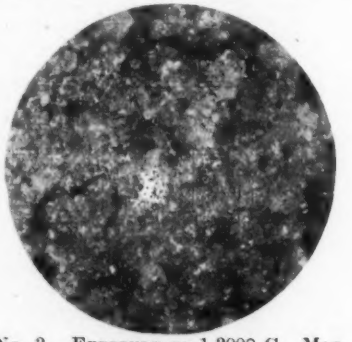
No. 1.—Normal Temperature. Mag. × 50 Diams.

Remarks. — Material Medium Strong and Fine. Works Well in Moulds, though a little Gritty. Small Quantities of Tin White Mica Visible in Sample.



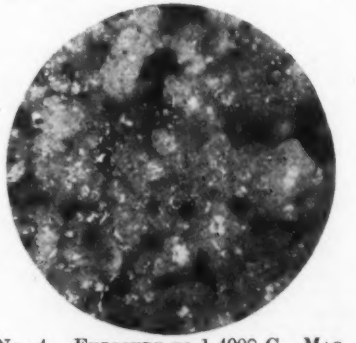
No. 2.—Exposure to 1,200° C. Mag. × 50 Diams.

Remarks.—Test Piece Expanded $\frac{1}{32}$ in. in the Form of a Camber in a Length of $2\frac{1}{2}$ in. Specimen Strong. Partial Fusion of the Smaller Grains taken Place.



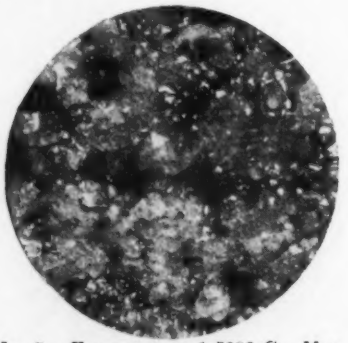
No. 3.—Exposure to 1,300° C. Mag × 50 Diams.

Remarks.—Test Piece Expanded as in Fig. 2. Specimen Strong. Material Begun to Fuse in Small Bunches, showing Pitting and Fissuring.



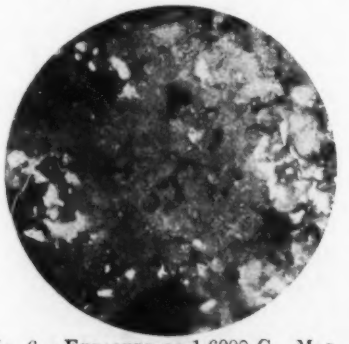
No. 4.—Exposure to 1,400° C. Mag. × 50 Diams.

Remarks.—Test Piece Expanded $\frac{1}{16}$ in. in the Form of a Camber in a Length of $2\frac{1}{2}$ in. Specimen Strong. Material Fused in Larger Bunches or Aggregates, showing much more Fissuring, due to Iron, etc.



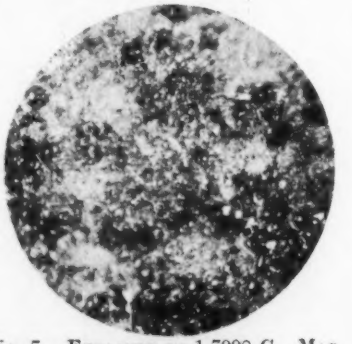
No. 5.—Exposure to 1,500° C. Mag. × 50 Diams.

Remarks.—Test Piece Expanded $\frac{1}{16}$ in. in the Form of a Camber in a Length of $2\frac{1}{2}$ in. Specimen Strong. Material nearly Completely Fused, showing Deep Fissuring and Pitting.



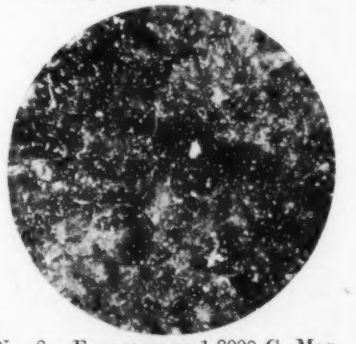
No. 6.—Exposure to 1,600° C. Mag. × 50 Diams.

Remarks.—Test Piece Expanded $\frac{1}{16}$ in. in the Form of a Camber in a Length of $2\frac{1}{2}$ in. Specimen Strong. No Exfoliation. Material Fused to a Dirty-grey Glass Heavily Pitted and Fissured with Iron.



No. 7.—Exposure to 1,700° C. Mag. × 50 Diams.

Remarks.—Test Piece Broken by Heat. Slight Exfoliation. Material considerably Fused to a Dirty-black Slag, showing Great Pitting and Fissuring.



No. 8.—Exposure to 1,800° C. Mag. × 50 Diams.

Remarks.—Test Piece Broken by Heat. Great Exfoliation. Material Completely Fused to a Dirty-black Slag, showing very great Fissuring and Pitting.

# Time Savers in the Jobbing Foundry.

By F. A.

It is quite a common occurrence in the jobbing foundry to receive patterns made without consideration of the best methods of moulding. The following article describes four different examples of castings which present no difficulty to the regular hand, who has become accustomed to the work and the way in which the patterns are made, but which to the new hand may give trouble and mean wasters in testing his abilities.

Fig. 1 shows a mould for a cylindrical tank 14 in. inside diameter, 22 in. long and only ⅜ in. thick in the body. The pattern was made in halves, the beadings at the closed and open ends being fixed to the body and immovable. The outside of the casting has

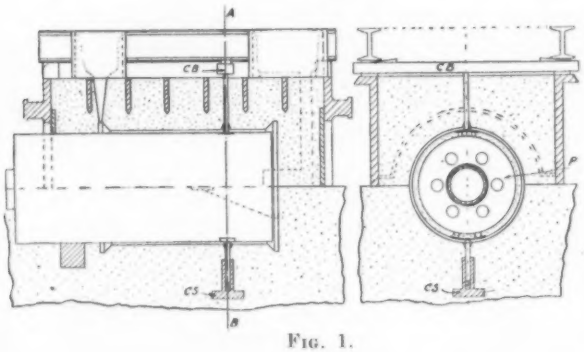



Fig. 1.

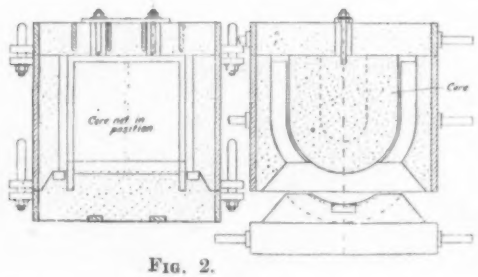



Fig. 2.

down from the box trunnion, but only transfers the lifting pressure to the box, which, assuming the runner-box is filled, is equal to about 23 cwts. This means a total weight required of 39 cwts., from which may be deducted the weight of the moulding box and sand, and core and barrel. If all the metal in the mould is fluid when pouring is finished, the whole of this upward pressure is acting but is rapidly reduced as the metal solidifies. By running the surplus metal off at the riser, level with the top of the moulding box, the lifting pressure is considerably reduced and it is advisable to adopt this method on all occasions when the strain is great and feeding is not necessary.

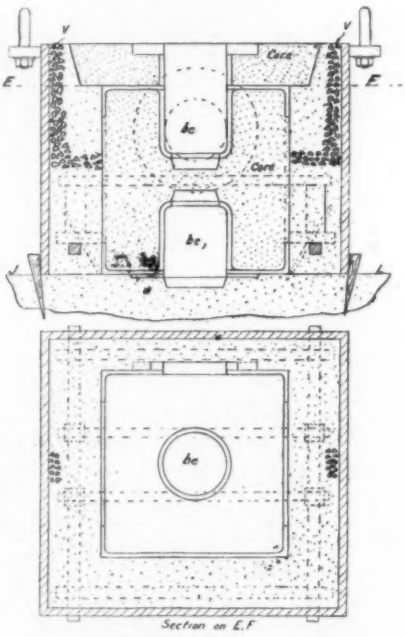



Fig. 3.

to be turned and the inside must have a good surface. The defects met with in these castings were the core lifting and leaving a thin top, or even a hole; the core sinking, due to improper support, which gave way when the top chaplet was secured; the chaplet sinking into the core, due to the hay-band being burnt; and white iron round the top chaplet plate, due to its chilling action.

The lift on this core was very great, amounting at least to 16 cwts. (neglecting that required on the mould), on account of the head of metal and the great surface of the core. The approximate lifting pressure on the core is equal to the diameter × length of core × height from top of runner-box to bottom of core, less ¼ of diameter, × 0.26 (all dimensions in inches), 0.26 being the weight in pounds of one cub. in. of cast iron, and the result being in pounds. The end lying in the print can be packed

The only core barrel available was about 5 in. diameter, so that the circular plates *P* shown in the end view were used to increase the size and wedged on the barrel. Instead of using chaplets with a plate attached for supporting and holding down the core, loose plates were bedded in the core and packed to one of the circular enlarging plates on the barrel. A ⅜ in. stem screwed at the end and tinned or red-leaded, was fixed in the chaplet stand *C S*, shown in the bed of the mould and set to the required thickness, ⅜ in., raised or lowered as necessary by addition to or removal of sand from the stand centre. A similar wrought-iron stem was placed in the top box, the lower end of which rested on the plate bedded in the upper face of the core, the upper end projecting through the top box. The core having been placed in position and the box lowered on, packing was placed on the box edge to support bearers for weight-

ing down. A strong cross-bar, *C B*, was laid across the box over the stem and under the weights and securely packed. If the cross-bar were weak, the lift on the core would cause some deflection, which would allow the core to lift, and in this case should be packed directly over the stem to the weight in addition to being packed at the ends.

This example is given to show the necessity for firmly securing such a core and mould down, and though it is not necessary to estimate strain in every case, it would have been advisable on this particular casting, as the weight used on the first one was only 10 cwts., this allowing the core to lift. The weight of the casting was only about 150 lbs. Such a casting would have been simpler to make on end, open end down, in a three-parted box, with either a green-sand or a loam core.

The example shown in Fig. 2 is a light guard, **U**-shaped, ¼ in. thick on the body and about ¾ in. thick on the top and side flanges, a central rib, about 4 in.

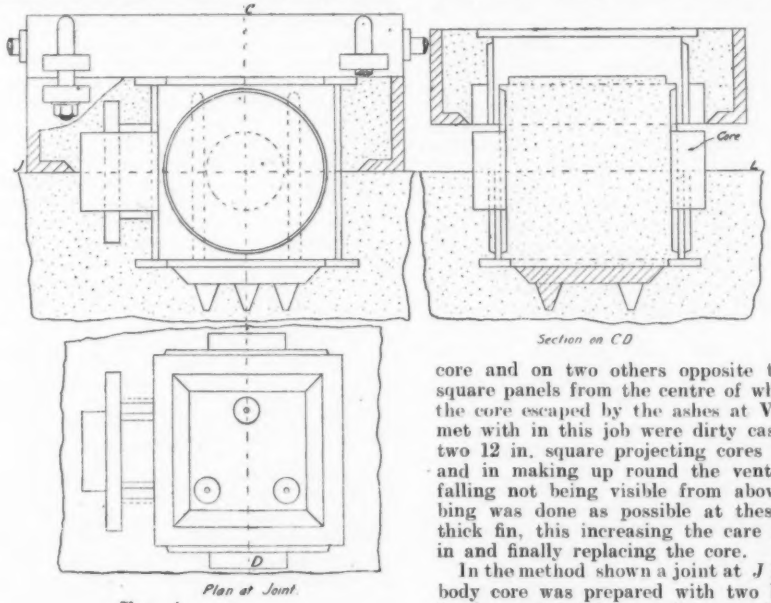



FIG. 4.

in width and ¾ in. thick, being formed on the inside by the core, as shown by dotted lines. The very short prints provided with this pattern did not give sufficient bearing for the core, and the use of sheet-iron plates (lining the prints for the core to rest upon to prevent damage when inserting the core) was objectionable, as they expanded when in contact with the metal, into the mould, causing the faces of the side flanges to be defaced.

The thickness at the bottom was uncertain, due to irregular cores, and lifting the core out had the effect of damaging the prints, especially if the core was badly balanced. When the core was replaced it was impossible to see any damage that had been done, or any dirt that might have got into the mould, so that great care was required, and many doubtful castings resulted.

To overcome the difficulty, the mould was made in a three-parted box, as shown, with a joint at the bottom. Sprigs were left projecting at the bottom of the finished mould and the core lowered in once and left there, the sprigs being pushed down by the core according to the thickness at the bottom. The top part, with holes cut through for the passage of hooked bolts, was placed in position and a good touch between core and top ensured, when the core was secured through the top. The top and middle boxes were lifted together, as shown in the right-hand view of Fig. 2, enabling the moulder to inspect the middle part from underneath for damage invisible from the top, also the bottom part, and to try the thickness at the bottom from the height of the sprigs previously inserted. By this method clean castings were obtained with a minimum of risk. A modification of this method is possible with several jobs of a similar character.

Fig. 3 shows a mould for a retort-house governor box, about 18 in. square and ¾ in. thick. The pattern was made with a large print at the top, a core of similar shape forming the outside of the branch, as shown in the elevation. The body core rested on one of the branch cores, *b c*, and cut through on three sides, there being on one side a round projecting core and on two others opposite to each other two square panels from the centre of which the vent from the core escaped by the ashes at V. The difficulties met with in this job were dirty castings through the two 12 in. square projecting cores scraping the sides and in making up round the vent outlet, any sand falling not being visible from above. As little rubbing was done as possible at these panels to avoid thick fin, this increasing the care required in trying in and finally replacing the core.

In the method shown a joint at *J L* was made. The body core was prepared with two holes at the same level, passing from panel to panel and half-way up the core. Two bars 1 in. square and projecting at each end were passed through the holes provided. When the core was lowered in the mould these bars were packed up from the supports provided when ramming up the mould, and shown in the sectional plan by dotted lines, and which also serve for carrying the outside part of the mould. The core secured, the vents were made safe from the entry of metal and carried out to the top joint at *V*. Any dirt or dust on the core was blown off, and the middle part with the core could be lifted from the bottom joint and the thickness shown by the projecting sprigs tested. The middle could be examined from underneath and the bottom face of the mould cleared of any loose sand, and the middle part again replaced. The core forming the branch was put in position and the mould closed ready for casting. Results from this method were more certain and the number of wasters from dirt was reduced to *nil*.

Fig. 4 illustrates a small governor box in connection with gas meters. In this case a joint was previously made level with the top, except on the side where the branch was placed, and here a vertical joint was necessary down to the centre of the branch body,

again rising on the slant at the extremity of the branch. It will readily be seen that the close proximity of the branch flange to the side of the box and the presence of the two strengthening brackets, like those shown in the plan of the mould, also the overhanging flange at the top of box, make this lift very delicate, and a fair amount of clearance cutting away from the vertical joint is required to avoid crushing when replacing the top, leaving a fairly strong fin on that part of the casting. The two holes at the sides presented some difficulty, as sheet-iron ferrules were not permitted on the prints, due to the marks they produced in the casting, and therefore the cores for these holes could not be set back till the centre green-sand core was replaced and then pushed forward without the possibility of damaging the prints, some portions of which might drop to the bottom of mould and, being under the core, could not be seen from the top. It was thus necessary to rub plenty of clearance off the ends and cut away a portion of the sand forming the bottom of the facing at each side of the green-sand centre core. The resultant castings by this method were often broken in removing the fin present in the holes.

The improved method is shown in Fig. 4. A level joint was made at the centre of the box and branch. The screws holding the branch and facings were removed as ramming proceeded. A middle part was used to lift the upper half of the mould and a joint made level with the top of the pattern. When the top had been removed the box portion of the pattern was withdrawn, leaving the branch and facings behind. The green-sand core was lifted out, finished and blacked and the inside of the mould similarly treated. The top was replaced, the two parts fixed together and lifted off at the joint of the branch and turned over. The branch was finished top and bottom and the green-sand centre core replaced in position, also the two side cores and the branch core, these being fitted closely to avoid a thick fin. The top and middle part were turned over, and the top lifted off the middle to allow the moulder to see round the mould while lowering the middle part into position. After trying the middle off to examine the prints for crushing, the top was replaced and made ready for casting. By this method excessive fin was avoided and cleaner and better-shaped castings were obtained. The three views show respectively a part section of the mould ready for pouring, a section at right angles showing the middle part ready for replacing, all cores in position, and a plan at joint line, *J L*, of the mould, no cores in position.

In each of the four examples shown the moulding boxes used were such as to make it convenient to adopt the methods without making fresh tackle, except in the case of Fig. 4, for which a loose plate was made and fixed to a bottom part, to serve for lifting off the upper part of the mould. There are several jobs of a similar kind to those mentioned in this article where the methods could be employed with advantage, with a net saving in the time, less anxiety for the moulder, and fewer wasters.

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Mr. E. W. Moir, Comptroller of Munitions Inventions, Ministry of Munitions, Princes Street, Westminster, London, S.W., has issued a letter to a number of Institutions, including the Iron and Steel Institute, in which he draws the attention of the members of the Institutions to the fact that an advisory panel of scientific and other experts, appointed by the Minister of Munitions, is assisting the Munitions Invention Department in the task of dealing with the large number of inventions that have been and are being received, every one of which is given consideration by the panel. This body is glad to consider also suggestions.

## Electric Melting of Ferro-Alloys.

In the course of a Paper on "The Electric Furnace and the Melting of Alloys," read by Mr. R. S. Wile before the Society of Iron and Steel Electrical Engineers at Pittsburgh, the author emphasised the advancing cost of certain ferro-alloys and the uncertainty as to future supplies caused by the war. In describing the Wile furnace (of which he is the designer) the author remarked that the advantages derived from introducing the alloy in a molten condition, other than those of distribution, etc., might be questioned. The percentage of saving varied with the amount of manganese, etc., added to the steel. As was well known, a large part of the manganese added to both open-hearth and particularly Bessemer steel was lost in freeing the steel of oxides, and the amount of manganese oxidised was less with a high-carbon than with a low-carbon steel; it decreased with the amount added. Thus, if 1 per cent. manganese were added to the bath 0.60 per cent. would be found in the steel (less 0.40 per cent.); if 0.60 per cent. be added, the steel would retain 0.40 per cent. (less 0.20 per cent.); the loss in one case being 40 per cent. and the other 30 per cent., and there was no assurance that all parts of the steel would show 0.60 per cent. or 0.40 per cent., as the case might be.

Commenting on his own investigations Mr. Wile said:—"We have carried out extensive tests to prove that there is no change in the alloy while melting, and to show the carbon and power consumption as well as the cost of linings in our furnace for this purpose. We have come to the following conclusions, using 80 per cent. ferro-manganese as a basis: That the average power consumption is nearly 800 kw-hrs. per ton; that the carbon consumption is never over 12 lb. per ton and rarely that, and that the lining cost is between 5d. and 1s. per ton, depending upon the rapidity of melting. This means that the cost with power at ¼d. per kw-hr. and carbon at 2d. will be between 18s. and 19s. per ton, exclusive of labour, which is incidental to the plant anyhow. This will add to the cost of the average steel between 1¼d. and 5d. per ton—a very small amount, which is easily dissipated in the reduced handling.

"Another point of saving is in closer calculations of the manganese. If the specification calls for 1 to 1.25 manganese, the proper amount can be melted to yield the 1 per cent. in the steel, thereby saving the 0.25 per cent. The results in melting this alloy in a Héroult furnace at Joliet are such, I understand, that the cost of the steel is reduced 2/100 of ¼d. Other data show that the power consumption in this type of furnace is 1,256 kw-hrs. per ton, and the electrode consumption 7s. per ton based on carbon at 2d. per lb. This is a higher cost than shown either in the Keller or Wile furnace, but may be accounted for by the large size of furnace and the small amount of alloy melted causing a greater radiation. Even at this higher figure the cost of the steel is reduced rather than raised, and a better steel results.

"It has been contended by some that the best practice is to add these alloys to the furnace rather than to the ladle, on account of the gases arising from the ladle causing spongy steel. This latter contention is undoubtedly true where the alloys are charged cold and may be to some extent if they are charged hot, as it does even when they are added to the furnace itself, but when it is considered that the loss of manganese or chromium goes on at the rate of about 12 points per minute while in the furnace it is doubtful if these gases, which are always present, are more costly in the end than the loss encountered from the waste of alloys.

# The Nature and Properties of Malleable Cast Iron.

It is not the writer's intention to discuss the varied applications that suggest themselves for malleable cast iron. The present purpose is rather to treat with the properties and production of the material and present the essential facts in such a light that users will be better able to judge where and when malleable cast iron is the most suitable material to employ. The physical properties of grey-iron castings are fairly well understood by engineers, and steel castings of various descriptions have also had close attention in regard to their application to different uses; but while malleable-iron castings have for the last century been steadily gaining ground in the approval of users, there is yet a much wider field in which they might be employed. Briefly, malleable cast iron is cast iron of a particular nature which has, by means of a specific process, been robbed of certain characteristics of the latter metal which are undesirable for the purposes which malleable cast iron has to serve. The chief of these characteristics are hardness and lack of ductility, making the metal difficult to work, brittle under shock, and weak under transverse stress. The change which takes place is both physical and chemical in its nature, but may be briefly stated as a change in the condition in which the carbon in the metal exists. According to the process of manufacture, whether Reaumur or black-heart, the chemical change is more or less pronounced, this change being an extraction of part of the carbon from the metal, thus bringing it more to the composition of a steel. This elimination of carbon would not alone, however, render the metal malleable or ductile; that characteristic is obtained by throwing practically all the remaining carbon out of combination with the iron and having it distributed through the crystals of metal as amorphous graphite, in which condition it exerts the influence of merely finely-divided impurities in a mass of ductile metal.

The effect just mentioned will be better appreciated when it is recalled that wrought iron, the most ductile form of commercial iron, is a similar mass of metal enclosing finely distributed impurities in the form of slag from its manufacturing process. In fact, malleable cast iron in many respects is closely related to wrought iron, both in its physical characteristics and microscopic structure, though not possessing ductility to the same degree. As illustrating the change in physical properties which occurs in malleableising the initially hard and brittle cast iron, as above mentioned, typical test results of both grey cast iron and malleable cast iron may be given:—

| Typical good— | Tensile strength | Elongation. | Transverse strength 12"centrs 1"× 1"bar | Deflection on 12in. bar. | Angle of bend without fracture. |
|---|---|---|---|---|---|
| | Tons per sq. in. | Per cent. | Cwts. | Inches. | Degrees. |
| Grey cast iron .. | 14 | Nil | 16 | 0.1 | nil. |
| White cast iron .. | 17 | Nil | 10 | — | nil. |
| Malleable cast iron (Reaumur).. .. | 22 | 5 | — | — | Through 90 |

Considerable variation on the above figures is, of course, obtained with different qualities of material, the figures being merely illustrative of the increased strength and ductility. Malleable cast iron may be bent, twisted and hammered, either hot or cold, and it is this feature combined with the increase in strength which renders it particularly valuable for many uses.

A common misconception is that the material can be welded, but this is not so, as it tends to disintegrate under the hammer when hot. There are two distinct processes of producing malleable cast iron, each giving its own characteristic product. The raw materials, too, are distinct, as will be mentioned later. The practice common in Great Britain and Europe generally is based on the discovery made by Reaumur, a French chemist, in 1722, that a particular class of iron when heated in a packing of red hematite ore became malleable. Reaumur's discovery received little attention until Samuel Lucas, of Sheffield, in 1804, took out a patent for practically the same process.

The other process of producing malleable cast iron is really a development, by Seth Boyden, of Newark, New Jersey, U.S.A., of the earlier discoveries mentioned. Boyden, working with an iron much lower in sulphur, produced a similar effect by heating the iron in other packing materials. This is the basis of the present-day American practice—a practice which is also to some extent followed in this country, suitable pig-iron being employed.

### Essentials of Reaumur Practice.

The essential features of the modern Reaumur practice are practically the same as enunciated by Reaumur himself in 1722, viz., the heating of a suitable cast iron in red oxide of iron. By this means a considerable portion of the carbon is removed by oxidation, and that remaining takes chiefly the form of temper or annealing carbon, about 0.5 to 0.7 being diffused in the matrix as laminated pearlite. The other elements (S, Si, P, and Mn.) are not materially affected.* The factors which are influential in effecting the change in the condition of the carbon, apart from the oxidation, are time and temperature, and for this reason it is necessary to raise the castings in the annealing oven to the requisite temperature and maintain that temperature sufficiently long to allow the reactions to be complete. These reactions may, briefly, be said to comprise (*a*) the elimination of carbon by oxidation and (*b*) the precipitation of carbon from the cementite.

Since the separation of the carbon into the temper-carbon form commences at the outer portions of the casting—those in first contact with the heat—and proceeds towards the centre, the oxidation of the carbon, which can only take place after precipitation, follows in the same way, being accordingly greater towards the outer rim of the casting. At different times various investigators have suggested various explanations of the decarburisation phenomena, some holding that the carbon diffused to the decarburised portions as the carbon from those portions was removed, the process thus continuing until the whole section was affected; but later research points rather to a penetration of the oxidising agent after the precipitation of the carbon has taken place. This naturally involves oxidation by a gas and the elimination of carbon in the gaseous form.

* It has been stated by some writers that the annealed samples show an appreciable diminution of sulphur, and that the increase of sulphur in ore that has been often used is to be accounted for by the oxidation of sulphur from the iron. This increase, however, more probably results from the sulphur in the furnace gases being absorbed by the ore and accumulating through continued use. This conclusion is borne out by R. H. Smith's experiments (See "F.T.J.," October, 1915, page 531).

The change in the carbon content of the metal during the annealing naturally varies, but may be as much as from over 3 per cent. in the white iron to 1.50 per cent. or less in the finished product. The effect of the change is, as stated, to bring the material nearer to the condition of a wrought iron or mild steel, with a consequent change in physical properties.

### Essentials of Black-Heart Practice.

Black-heart malleable cast iron, while in many respects closely allied to the Reaumur product, is distinct both in the appearance of its fracture and in the actions involved in its production. The essential function in the process of its production is not the elimination of part of the carbon as in Reaumur practice, but in the changing of the form of the contained carbon from the combined to the free condition. The skin of the casting certainly undergoes decarburisation, but the main body of the metal merely has its graphite precipitated into the "temper" or annealing form, the structure then being amorphous carbon in a matrix of ferrite. Owing to the absence (virtually) of oxidation of the carbon, the packing material may be almost anything that will afford suitable protection from the furnace gases and prevent undue distortion during heating; and a variety of materials have at times been successfully employed. An essential in the process, however, is that the sulphur content of the iron be low, since the presence of sulphur tends to prevent the separation of the carbon. The annealing temperature, too, is lower than in Reaumur practice, which point has been dealt with previously in our columns.

Since the two processes give distinct products, it will be as well to differentiate them when discussing the physical properties.

### Physical Properties of Reaumur Malleable Cast Iron.

*Tensile Strength.*—The tensile strength of this material varies from 17 to 27 tons per square inch, the elongation from 2 to 6.5 per cent., and the reduction of area from about 2 to 6 per cent. The very high tensile strengths are obtained only at the expense of ductility. Up to 32 tons per square inch tensile strength can be obtained by the addition of a small amount of steel scrap (usually 2 to 5 per cent.) to the furnace charge. It is important to remember, however, that with reduced elongation a tendency of the metal to be brittle is experienced.

The following figures represent tests made by Dr. W. H. Hatfield on Reaumur malleable cast iron:—

| Maximum stress. | Elongation. | Reduction of area. |
|---|---|---|
| Tons per sq. in. | Per cent. in 2 in. | Per cent. |
| 23.0 | 6.0 | 5.0 |
| 21.3 | 4.5 | 4.5 |
| 19.97 | 4.2 | 5.0 |
| 23.20 | 6.5 | 3.5 |
| 27.07 | 3.5 | 4.0 |
| 20.93 | 4.2 | 5.2 |
| 25.60 | 5.0 | 4.6 |
| 26.80 | 4.6 | 3.6 |
| 23.72 | 5.2 | 4.1 |
| 21.08 | 4.7 | 3.8 |
| 19.78 | 3.9 | 4.7 |
| 22.42 | 4.9 | 6.0 |

The British Admiralty Specification demands a maximum tensile strength of 18 tons, with minimum elongation of 4½ per cent. on 3 inches.

*Ductility.*—This property, as represented by the elongation under stress, does not appear to bear any definite relation to the tensile strength. A high tensile strength will often be found to be accompanied by a lower elongation than that associated with a lower tensile strength: while in other cases high strength may be obtained with a relatively high elongation. On the whole, however, the highest elongation is not usually obtained with high tensile strength. Elongation is measured by marking, prior to testing, a defined length of the test bar and measuring the length on piecing together the two ends of the broken bar.

*Bending.*—The bending test (corresponding to the transverse stress in grey cast iron) is generally made on a bar of 1 in. by ⅝ in. section, this being bent round a 1 in. radius. The British Admiralty specification requires that it shall bend through an angle of 90 degrees without showing signs of fracture. This represents good material, for many specimens will not come up to that requirement, the range of commercial products being from 45 degrees to 90 degrees. The latter figure, however, can be well exceeded in some cases, even with comparatively high tensile strength.

*Resistance to Shock.*—The writer has no data available on this point. The results of service, however, appear to indicate that good malleable cast iron is at least equal to mild steel, except under heavy shock, when steel is superior. For withstanding vibration or repeated light shock, malleable cast iron in some cases has appeared to be the superior of the two, but in the absence of careful comparative tests with Reaumur metal it is not safe to assume that this is actually the case in general. Some users' experience of black-heart material appears to uphold the contention.

### Physical Properties of Black-Heart Malleable Cast Iron.

*Tensile Strength.*—The tensile strength of the American variety of malleable cast iron usually ranges from 15 tons to 25 tons per square inch, though over 28 tons has been recorded. As previously mentioned in connection with the Reaumur product, these high tensile results are often accompanied by a decrease in the resistance to shock. The specification of the American Society for Testing Materials requires that the tensile strength shall not be less than 40,000 lbs. (about 18 tons) per square inch, with not less than 2¼ per cent. elongation on 2 inches.

*Transverse Strength.*—The American test for this property is made on a bar, either 1 in. by 1 in. or ½ in. by 1 in., on knife edges 12 in. apart, deflection being also measured. A good iron should give over 40 cwt. transverse test results, with a deflection of not less than ½ in., the general run of work giving from 32 to 44 tons, with deflection ranging from ½ in. to over 2½ in. in some cases. The specification of the American Society for Testing Materials stipulates not less than 3,000 lbs. (26.78 cwt.), with a minimum deflection of ½ in.

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**ASBESTOS CLOTHING FOR THE FOUNDRYMAN.**—There have been many attempts to protect foundry workers from the effects of splashed or spilled molten metal, and the latest is the supplying of asbestos clothing. Messrs. Wheeler & Holcomb, of Chicago, U.S.A., are now marketing asbestos clothing, including gloves, mittens, leggings, aprons, trousers and coats, for use in the foundry. The asbestos is specially treated to prevent the nap from rubbing off and the fibre is smooth, which, it is claimed, adds to its tensile strength and fireproof qualities. The fabric is sufficiently flexible to allow materials to be handled readily and it is claimed it is not brittle. This departure in protective devices would appear to be on the right lines, once the average workman's constitutional objection to protection is overcome.

# Desulphurisation in Cupola Practice.

A series of experiments, with the object of determining the behaviour of sulphur in cupola melting has been carried out by Otto Vollenbruck, and the more important of these have been summarised in a recent issue of "Stahl und Eisen," and translated by "The Iron Age."

### Absorption of Sulphur by Lime.

The absorption and removal of sulphur is accomplished by different additions of lime in a cupola. Under otherwise uniform conditions, that is with the same cupola practice and a charge of 750 kg. of full-sized coke, 600 kg. of iron and 45 kg. of fine coke, the lime additions shown in Table I. were employed in the different trials. The tests were taken 15 min. after the appearance of the first iron in the forehearth, and at the junction of this and the cupola. The examination of the slag and the iron gave the following results:—

TABLE I.—*Sulphur Remaining in the Iron with Varying Lime Content of Cupola Slag.*

| Limestone additions in per cent. of the weight of coke. | Sulphur content of the cast iron. | Sulphur content of the slag. | Lime content of the slag. |
|---|---|---|---|
| | Per cent. | Per cent. | Per cent. |
| 0 | 0.124 | — | — |
| 3 | 0.120 | 0.057 | 10.90 |
| 6 | 0.118 | 0.057 | 13.04 |
| 9 | 0.111 | 0.061 | 14.26 |
| 12 | 0.087 | 0.062 | 14.74 |
| 15 | 0.083 | 0.062 | 16.15 |
| 18 | 0.084 | 0.062 | 16.40 |
| 21 | 0.087 | 0.062 | 18.36 |
| 24 | 0.084 | 0.078 | 19.15 |
| 27 | 0.088 | 0.116 | 23.65 |

The charge had at the most less than 0.05 per cent. sulphur. The lowest sulphur content of the iron after the melting was 0.08 per cent., and of this 0.03 per cent. comes from the coke, an enrichment which cannot be prevented by lime conditions. The slag is enriched with sulphur up to an addition of 27 per cent. lime, but the removal of sulphur from the iron ceases when the slag contains 14.74 per cent. of lime, at which stage a further addition of lime is useless. From this point on it is accompanied only with a removal of sulphur from the gases of the coke.

### Effect of Lime and Manganese Silicates.

The effect of lime and manganese silicates on the sulphur content of the iron was tested by laboratory experiments. For clear working conditions a pig-iron was used containing about 1 per cent. sulphur (0.983). By melting together chemically pure calcium carbonate, $CaCO_3$, manganese oxide, MnO, and silica the following compounds were obtained:—

Calcium sesquisilicate, $4CaO.3SiO_2$.
Manganese sesquisilicate, $4MnO.3SiO_2$.
Calcium bisilicate, $CaO.SiO_2$.
Manganese bisilicate, $MnO.SiO_2$.

*Results with Sesquisilicates.*—The iron used contained 3.49 per cent. carbon; 0.22 per cent. manganese; 3.047 per cent. silicon, and 0.933 per cent. sulphur. The crucible charge was always 50 grammes, of which 30 grammes was iron and the remaining 20 grammes was either one of the above, lime silicate, a manganese silicate, or a mixture of both, as shown in Tables II. and III. Two sets of experiments were carried out, one using only sesquisilicates and the other the bisilicates.

TABLE II.—*Effect of Calcium and Manganese Sesquisilicates on the Sulphur Content of Iron.*

| Charge. | Sulphur in slag. | Iron. | | |
|---|---|---|---|---|
| | | Sulphur. | Silicon. | Manganese. |
| | Per cent. | Per cent. | Per cent. | Per cent. |
| Sulphur-bearing iron .. .. | — | 0.933 | 3.047 | 0.22 |
| 1. Ca-sesquisilicate, 20 g.; iron, 30 g. .. .. | 1.268 | 0.061 | 3.348 | 0.22 |
| 2. Ca-sesquisilicate, 10 g.; Mn-sesquisilicate, 10 g.; iron, 30 g. .. .. | 1.297 | 0.051 | 2.263 | 5.581 |
| 3. Mn-sesquisilicate, 20 g.; iron, 30 g. .. .. | 1.276 | 0.054 | 2.530 | 6.148 |

The effect of calcium-sesquisilicate is to reduce the sulphur from 0.933 per cent. to 0.061 per cent. By the substitution of manganese-sesquisilicate for the calcium compound, the sulphur content is influenced in a similar manner. The increase in the silicon in test No. 1 is perhaps due to the reduction of silica by carbon; the decrease in the silicon in tests 2 and 3 is caused by the effect of the manganese oxide content of the slag, which hinders the reduction of the silica. The increased manganese content, in the case of both the calcium and manganese silicates, brings about an equally strong lowering of the sulphur.

*Results with Bisilicates.*—Substituting the bi- for the sesquisilicates, the absorption of sulphur was less.

TABLE III.—*Effect of Calcium and Manganese Bisilicates on the Sulphur Content of Iron.*

| Charge. | Sulphur in slag. | Iron. | | |
|---|---|---|---|---|
| | | Sulphur. | Silicon. | Manganese. |
| | Per cent. | Per cent. | Per cent. | Per cent. |
| Sulphur-bearing iron .. .. | — | 0.933 | 3.047 | 0.22 |
| 4. Ca-bisilicate, 20 g.; iron, 30 g. .. .. .. | 1.016 | 0.277 | 3.400 | 0.22 |
| 5. Ca-bisilicate, 15 g.; Mn-bisilicate, 5 g.; iron, 30 g. | 1.071 | 0.158 | 3.218 | 2.158 |
| 6. Ca-bisilicate, 10 g.; Mn-bisilicate, 10g.; iron, 30g. | — | 0.129 | 7.049 | 6.148 |
| 7. Ca-bisilicate, 5 g.; Mn-bisilicate, 15 g.; iron, 30 g. | 1.147 | 0.142 | 2.812 | 3.117 |
| 8. Mn-bisilicate, 20 g.; iron, 30 g. .. .. .. | 1.286 | 0.135 | 3.116 | 2.947 |

This table shows that the absorption of sulphur in the presence of calcium and manganese bisilicate slags is less than with the sesquisilicate slags. Technically commercial value is not attained. The manganese-bisilicate shows a 50 per cent. stronger desulphurising power than the calcium-bisilicate even by the substitution of four parts of calcium-bisilicate by manganese-bisilicate. The silicon content of the iron changes but little. Test No. 6 is not to be considered because the slag was coked by overheating. Successful melting must be maintained at a definite temperature, between 1,450 and 1,500 deg.

With a mixture of 20 g. of calcium-trisilicate, $2CaO.3SiO_2$ and 30 g. of iron, the sulphur content was reduced from 0.933 per cent. to 0.547 per cent.

The quantity of slag in any of these experiments was 66.6 per cent. of the iron. With a mixture, for example, of 1 g. of calcium-bisilicate and 30 g. of high-sulphur iron, the slag produced was only 3.3 per cent., a condition which obtains in cupolas. But in the experiment there was no desulphurising, which

demonstrates how important the quantity of slag is for desulphurisation. In cupola practice a desulphurising of the iron is less likely than a diminished transference of sulphur from the coke.

### Desulphurisation by Varying Blast Pressures.

In a small experimental cupola, 100 mm. in diameter, experiments were carried out to determine the absorption of sulphur under different blast pressures. The tuyeres were situated so low that it was not practicable to use large layers of full-sized coke. Therefore sulphur absorption from this was not considered. In order that the cupola should not freeze much finer coke was necessary than in ordinary practice. The coke charge was 40 per cent. The results of the experiments were as follows:—

TABLE IV.—*Effect of the Coke and Blast Pressure on the Sulphur Content of Iron.*

| | Sulphur. | Silicon. | Manganese. | Carbon. |
|---|---|---|---|---|
| | Per cent. | Per cent. | Per cent. | Per cent. |
| The iron before the remelting . Charges. | 0.082 | 3.207 | 6.42 | 3.29 |
| 1. 0.2 g. coke / 0.5 g. iron. \ Little wind . | 0.169 | 2.451 | 4.518 | 2.84 |
| 2. 0.2 g. coke / 0.5 g. iron. \ Much wind . | 0.127 | 2.877 | 4.865 | 3.09 |
| 3. 0.1 g. coke / 0.5 g. iron. \ Little wind . | 0.143 | 2.234 | 5.213 | 3.18 |
| 4. 0.1 g. coke / 0.5 g. iron. \ Much wind . | 0.095 | 2.746 | 5.560 | 3.22 |

In experiment No. 1, in which the smallest amount of blast possible was used, the sulphur increased decidedly; it doubled. Since the full-sized coke was absent, in the weakly oxidising flame of the fine coke the lowered carbon monoxide could not enrich itself. In the second trial, with much blast, less sulphur was absorbed than in the first experiment. A larger part of the sulphur in the coke must escape with the gases. Silicon, manganese and carbon decreased less also.

In order to obtain a more reasonable absorption of sulphur, melting was attempted using only 20 per cent. coke with little blast; under these conditions, in trial No. 3, still high sulphur, 0.143 per cent. was obtained. Only by excess of wind and 20 per cent. coke, in trial No. 4, was a small sulphur absorption obtained. Success in melting iron without the absorption of any sulphur was achieved and indeed in the absence of any slag. To form a slag the coke consumption would have been higher and also the absorption of sulphur.

### Carbon as a Desulphuriser.

In order to study the influence of carbon on the sulphur content of iron, a series of sulphur-iron alloys was made by melting together nail scrap and sulphur. These products had the following percentages of sulphur:—36.29, 29.10, 26.44, and 1.45 per cent. The alloy with 36.29 per cent. sulphur corresponds nearly to the formula FeS. To these alloys excess of sugar carbon was added and the mixture melted. The results of these trials are shown in Table V.:—

TABLE V.—*Influence of Carbon on the Sulphur Content of Iron.*

| | First. | Second. | Third. | Fourth. |
|---|---|---|---|---|
| | Per cent. | Per cent. | Per cent. | Per cent. |
| Sulphur content before carburisation .. .. .. | 36.290 | 29.100 | 26.439 | 1.45 |
| Sulphur content after carburisation .. .. .. | 29.430 | 24.087 | 22.975 | 1.25 |
| Carbon content.. .. .. | 1.815 | 3.998 | 4.094 | 4.14 |

These show that the affinity of iron for carbon is reduced by the presence of sulphur and that carbon is not practicable as a desulphurising agent.

### Effect of a More or Less Oxidising Flame.

The question whether, in a more or less oxidising flame, the sulphur in iron is correspondingly burned to $SO_2$ was investigated. A foundry iron containing 0.538 per cent. sulphur was poured into thin rods. A more or less strongly oxidising flame was applied to rods of 10 mm. and the drops as melted received in a crucible. The result is shown in experiment No. 1 in Table VI. In the reducing part of an illuminating gas flame much air was introduced and this was heated up by as much oxygen as possible until the very thin rods melted, the effect being shown in experiment No. 2 in the same table. In the third experiment rods of only 3 mm. were used and the admission of oxygen reduced to a minimum in the oxyhydrogen blast flame. Table VI. shows that the absorption of sulphur is greater the stronger the oxidising flame. A limit is set to desulphurising only when the melting effect of the flame reduces the ability to take up oxygen. In a cupola no extensive desulphurisation is possible by means of oxidising gases because the products of the combustion of the coke contain $SO_2$ and the molten iron absorbs it.

TABLE VI.—*Influence of a More or Less Oxidising Flame on the Sulphur Content of Iron.*

| | Sulphur. | Silicon. | Manganese. | Carbon. |
|---|---|---|---|---|
| | Per cent. | Per cent. | Per cent. | Per cent. |
| 1. The iron before melting .. | 0.538 | 3.650 | 0.678 | 3.30 |
| Melted in a strongly oxidising oxyhydrogen blast flame .. .. .. | 0.336 | 3.422 | 0.568 | 2.96 |
| Per cent. of original content.. .. .. | 63.5 | 94.00 | 84.00 | 90.00 |
| 2. The iron before melting .. | 0.443 | 2.966 | 0.459 | 3.11 |
| After melting in an oxidising illuminating gas flame .. .. .. | 0.282 | 2.684 | 0.459 | 2.03 |
| Per cent. of the original content .. .. .. | 63.5 | 90.00 | 100.00 | 65.00 |
| 3. The iron before melting .. | 0.515 | 3.00 | 0.459 | 3.18 |
| After melting in a weakly oxidising oxyhydrogen blast flame.. .. .. | 0.341 | 2.82 | 0.393 | 3.09 |
| Per cent. of the original content .. .. .. | 60.00 | 94.00 | 86.00 | 97.00 |

### Remelting High-Sulphur Iron in Carbon Crucibles.

Repeated remelting in carbon crucibles of foundry iron rich in sulphur was followed by a slight desulphurisation, as Table VII. shows:—

TABLE VII.—*Effect of Remelting on the Sulphur Content of Iron.*

| | Sulphur. | Silicon. | Manganese. | Carbon. |
|---|---|---|---|---|
| | Per cent. | Per cent. | Per cent. | Per cent. |
| Original composition .. .. | 0.538 | 3.65 | 0.678 | 3.30 |
| After the first remelting .. | 0.515 | 3.00 | 0.459 | 3.18 |
| After the second remelting .. | 0.443 | 2.96 | 0.459 | 3.11 |

THE STEEL COMMITTEE reported to the Council of the Newcastle Chamber of Commerce, on October 5, that since the last meeting it had issued 152 certificates, the total number issued now being 230. The total fees received for these certificates aggregated £27 16s. 11d. A communication had been received from the Admiralty asking the committee's opinion as to the desirability of privileging certain firms to export steel without licences, and the committee had replied adversely on the ground that it would create invidious distinctions, and cause ill-feeling.

# Methods of Hardness Testing of Cast Iron.

Writing in "The Iron Age," recently, G. S. Evans discussed the subject of the relation of hardness to strength and other properties of cast iron. Manufacturers and users of rolled steel and steel products, he remarked, were quick to see the value of this method of testing, so that to-day the hardness test was being made use of in a great number of plants in controlling the quality of their output. Although the hardness test was of equal, if not greater, value to producers of chilled, malleable and grey iron castings, it was seldom used in that connection.

Tables I., II. and III. were given as showing a few examples of the relation between hardness, strength

TABLE I.—*Showing the Relation Between Hardness and the Strength of Chilled Carwheels.*

| Sample. | Hardness of single plate. | Hardness of surface of chill. | M.C.B. drop test number of blows. | | M.C.B. thermal test minutes to crack. | |
|---|---|---|---|---|---|---|
| | | | To crack. | To break. | In plate. | Through tread. |
| | | | | | Min. Sec. | Min. Sec. |
| 1 | 125 | 444 | 53 | 101 | — | — |
| 2 | 140 | — | 31 | 79 | — | — |
| 3 | 176 | 472 | 15 | 31 | — | — |
| 4 | 196 | 513 | 6 | 11 | — | — |
| 5 | 196 | — | — | — | 1 41 | 2 06 |
| 6 | 199 | — | — | — | 0 53 | 1 17 |
| 7 | 147 | — | — | — | No crack | at 5 min. |
| 8 | 163 | — | — | — | No crack | at 5 min. |

TABLE II.—*Showing the Relation Between Hardness and the Strength Machineability of Light Grey-iron Castings.*

| Sample. | Hardness of section. | Relative drilling time through ½ in. section with a constant pressure. | | Comparative strength or brittleness. |
|---|---|---|---|---|
| | | Min. | Sec. | |
| 1 | ·202 | 4 | 41 | Comparatively strong, but very brittle. |
| 2 | 215 | 4 | 53 | Comparatively strong, but very brittle. |
| 3 | 143 | 2 | 2 | Strong and more ductile. |
| 4 | 156 | 2 | 7 | — |
| 5 | 185 | — | | Showed good strength. |
| 6 | 128 | — | | Showed good strength. |

TABLE III.—*Showing the Relation Between Hardness and the Transverse Strength and Deflection of 1¼-in. Round Test Bars.*

| Sample. | Hardness. | Kind of iron. | Breaking load with 12 in. between supports. | Deflection in inches. |
|---|---|---|---|---|
| 1 | 137 | Carwheel | 3,300 | 0.176 |
| 2 | 205 | Carwheel | 4,150 | 0.122 |
| 3 | 196 | Semi-steel | 4,295 | 0.173 |
| 4 | 217 | Semi-steel | 4,430 | 0 162 |
| 5 | 116 | Machinery | 2,470 | 0.139 |
| 6 | 153 | Machinery | 3,240 | 0.185 |

and other properties of chilled car-wheels, chilled mould-boards, light grey-iron castings and grey-iron test bars. These were isolated cases selected from among the few tests that the writer had been able to make, and were given not as conclusive evidence but to demonstrate in a limited way the possibility of the value of hardness tests in studying the properties of cast iron.

Continuing, the writer said:—"The hardness of an iron is dependent upon its structure: then, knowing the hardness we should be able to judge as to the structure and, *vice versa*, knowing the structure we can estimate the hardness. It is evident that this method of testing is invaluable in studying and controlling the properties of cast irons for different purposes, and it is of special value in controlling chilled-iron mixtures such as plough points, mould-boards, car-wheels, chilled rolls, etc.

"There are several different makes of special machines for making the ball impression test, but in the absence of these it can be made with considerable accuracy on an ordinary universal tension-compression or a transverse testing machine, capable of exerting and accurately measuring the required pressure, by using special attachments made adaptable to the particular machine. Two different types of such attachments are illustrated in Figs. 1 and 2. Fig. 1 shows a sectional view of the attachment designed especially for use with a Riehle 100,000-lb. capacity universal testing machine, and Fig. 2 a perspective view of the attachment applied to a Tinius-Olsen 10,000-lb. capacity transverse testing machine.

"To make the test with a universal machine it is arranged as for a compression test; with a transverse machine the sample being investigated is placed upon a transverse support and the pulling head, to which

FIG. 1.

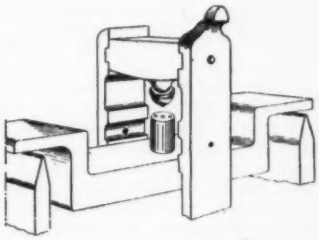


FIG. 2.

the attachment is fastened, is arranged midway between the two supports, as illustrated by Fig. 2. In making the compression the ball is first brought into contact with the plane surface of the specimen, the weight on the beam is next set to the required load and the pressure gradually applied until the beam floats, the time noted and sufficient additional pressure applied, if necessary, to keep the beam floating for 15 seconds, after which the load is removed and the diameter of the spherical indentation measured in millimetres. It is best to make two or more impressions on each sample and take the average of the final result, otherwise local irregularities in the specimen and probable variations applying the pressure may sometimes give erroneous results.

In order to obtain correct comparative results it is necessary that uniform conditions be maintained. A standard set of conditions should be established for each general class of materials such as chilled cast iron, ordinary grey cast iron, structural steel and non-ferrous metals. A 10 millimetre ball with a load of 5,000 kilograms (11,023 lbs.) is recommended for testing chilled iron; 3,000 kilograms (6,614 lbs.) for grey iron and steel, in each case subjecting the sample to the pressure for 15 seconds; and a load of 500 kilograms (3,307 lbs.) for testing non-ferrous metals, subjecting the sample to the pressure for 30 seconds.

C

The hardness numerals are inversely proportional to the size of the impressions, *i.e.*, the smaller the diameter of the impression, the greater the hardness number, and *vice versa*, the larger the diameter, the smaller the number; or, in other words, the hardness number varies in direct ratio to the hardness of the material, *i.e.*, the greater the hardness number, the greater the hardness itself.

The hardness number is found by dividing the load by the area of the impression. This may be accomplished by use of the following formula:—

$$\text{Hardness} = \frac{P}{\frac{\pi D}{2}(D - \sqrt{D^2 - d^2})}$$

P is the load, D the diameter of the ball, and d the diameter of the impression. With the aid of the Brinell table of hardness it is only necessary to measure the diameter of the ball impression and find the hardness number corresponding to the diameter.

The hardness testing attachments here described are protected by United States letters patent, No. 1,120,461.

## What should the Foundry Foreman Know?

By R. A. Miles.

When a young ambitious moulder makes application for a position as foreman moulder he is usually quite in the dark as to the kind of work produced, and the number of moulders or total hands employed. The applicants appear before the directors, or the owner, and the works manager. Now in most cases not one of these latter has had any practical training, but they have commercial knowledge, which the young aspirants have had no possible chance of acquiring. Applicants are often plied with questions that are unfair—unfair to the employer because he might miss the best man, and unfair to the man because his previous employers never allowed him the opportunity to become acquainted with such facts. For instance, applicants are asked how much coke per ton they would require to melt the iron. This question to men who have had to deal with their own particular class of work in their own cupola does not present much difficulty, but young men never having had charge of the melting plant before, knowing nothing of the conditions and facilities in the shop they are desirous of controlling, are more often than not afraid to commit themselves, for obvious reasons. Again, the man who finds the money may ask the applicant, "How much per cwt. can you produce castings like this for?" The young man probably makes a good guess, or maybe he is honest enough to say he does not know. If it is a small casting he may from previous shop piecework rates be able to give a satisfactory reply as far as regards the actual moulding cost, but it is most certain that the questioner wants his opinion on total labour cost, which must vary considerably in some foundries according to the situation and conditions.

Eventually one of the applicants is appointed to the post, and he very quickly discovers that there are many things he has to learn. It is the object of the writer to help youthful applicants to such positions by mentioning a few of the duties he may have to perform.

In the first place, it is essential that he should have had a good practical training at his trade, experience in green sand and dry sand, and the making of cores. He should be a fair scholar and be able to quickly calculate weights of castings, etc. He should be able and ready to make rough, readable sketches, and should have at least an elementary knowledge of chemistry. He will have to keep his eye on his stock of materials, and order fresh supplies before he is quite without. The office order department should give him some assistance by informing him how long it takes to deliver each kind of stock from date of ordering. For instance, his red sand may be obtained locally, and could be delivered the same day as ordered, but his road sand or ganister may have to come 60 or 70 miles and may take a week or even more.

It is a good plan to make a tabulated list of the materials which it is his duty to watch, and also the time necessary for delivery, and to make periodical visits to the storage bins to find out the position. He must also see that all machinery bearings are cleaned and oiled regularly and should hold someone responsible. He must see that the crane drivers sweep the dust from the cranes and oil them periodically, and if he has any regard for the health of his men he must also see that the walls are swept down occasionally and whitewashed within the specified time allowed by the Factory Act. The sanitary conveniences must also be attended to, and he should hold someone responsible for this. He must know all about the Insurance Act and be able to instruct new starters how to register their time. He will be expected to be able to remember when any particular casting was made or why such a casting was a waster. He must be able to instruct the coremakers how to make the core-irons, and also the cores, in the best manner. His knowledge of machine work and plate and plaster methods should also be extensive, for if the foreman can tackle the job himself it carries great weight with the men. He must have such knowledge of the cupola as will enable him in emergency to tackle the front or the inside patching.

He should be able to read drawings and be able to advise the foreman pattern-maker as to the best way to mould any piece of casting. It would also be advisable if he learned to drive the overhead traveller. He must see that the roof gutters are cleaned out now and then, or else he may lose a few moulds when heavy rain comes. Compressed air for sand-blast and machine moulding, and for fettling-shop cranes, should also claim the foreman's attention, and he would do well to make himself thoroughly acquainted with the plant.

He must know a little about electric motors and fuses and also the lights. He must be able to detect any fault in the running of the fan, hoist, or sand mixer, and whilst keeping his eye on these things, he must also see that each and every moulder performs a good day's work. He should see that unskilled men do the unskilled portion and the skilled men the skilled portion of the labour, and should learn that every man is of a different nature. He will have to be tactful and diplomatic in his dealings with both men and masters to make himself efficient.

Lastly, he should never get the opinion that he knows it all, and should never miss an opportunity of visiting any other foundry, as interchange of views and methods is the best food for thought he can possibly obtain.

# Practical Science and Physics in Foundry Work.*

By T. W. Aitken.

It is impossible to do full justice to this subject in brief space, and the writer purposes only introducing a few of the chief points of importance. Reference to the records of alchemy, of about the 14th Century, shows that the alchemist studied and observed every change in his process of heating and melting metals, but that he worked under certain beliefs, the chief being, that if he could prepare the Philosopher's Stone this would contain the power of transmuting the baser metals into pure gold. If all the workers of metals of the present age studied and observed as closely as they, no doubt we should be nearer being masters of our trade than we are at present. In order to follow up the scientific side of foundry practice, a little knowledge is necessary of chemistry and physics, and for the assistance of those who have not been able to study these subjects several important points may be briefly summarised. In chemistry everything that has weight is known as matter, of which there are three forms, *i.e.*, solid, liquid and gaseous. Matter is susceptible of a variety of changes, some of which are regarded as physical and others as chemical. These changes are worthy of a little consideration, for in foundry work many of these have to be considered.

Matter is regarded by chemists and physicists as being composed of aggregations of minute particles, whether it be solid, liquid or gaseous. These particles or molecules (little masses) of any particular substance are all alike; the actual sizes of molecules is a matter which has not yet been determined with exactness, but it is stated that their size is less than half of that of a single wave-length of light (a wave-length of the blue ray is given as 0.0000169 inch), therefore they are beyond the visual limits of the microscope.

In the strictest sense, matter is not homogeneous, since it consists of aggregations of molecules, between which there exist certain interspaces. The forces which similar molecules exert upon each other are regarded as physical, not chemical. These forces are either attractive in their nature or repellent. The attractive forces tend to draw the molecules closer together, and thus to cause the substance to assume the solid state, while repellent forces tend to separate the molecules and to make the substance pass into the gaseous condition. Changes which matter undergoes by the action of these forces are physical changes. Heat applied to a solid substance whose molecules, being all similar, are being drawn close together by their attractive force, tends to overcome this attractive force and convert it into the repellent force, this being entirely a physical change.

Most molecules are again comprised of still smaller particles (atoms) which are held together by another force called chemical affinity or chemical attraction. The application of heat does not overcome this chemical affinity unless a chemical change takes place. In the molecules of some substances the atoms present are of the same kind; these are known as elements. When the molecules are composed of atoms which differ from one another, the substances are known as compounds. Copper, therefore, as all the atoms are of the same kind, is an element and water, which is composed of hydrogen and oxygen atoms, is a compound.

There are about 76 elements, but in foundry practice only a few have to be considered, these including the metals iron, copper, tin, zinc, lead, manganese, nickel, aluminium, mercury, bismuth, antimony, tungsten, titanium, vanadium and calcium, and the non-metals carbon, oxygen, nitrogen, arsenic, silicon, sulphur and phosphorus. It has been found that when these elements combine together to form compounds, they always do so in definite proportions. Thus, iron and sulphur mixed in any proportion, if heated together, will combine to form an entirely different substance, but always in the proportion of 56 parts by weight of iron to 32 parts by weight of sulphur or multiples of these figures. A natural substance known as pyrites is a compound of iron and sulphur in the proportion of 56 parts iron and 64 parts sulphur, that being double the proportion of sulphur.

Common salt contains two atoms in its molecules, one an atom of chlorine (a yellow gas, intensely suffocating and poisonous) and the other an atom of sodium, which is a soft silver-like metal, which takes fire in contact with water. Some elements have a greater affinity for certain elements than others, and this remarkable selective power possessed by the atoms of different elements lies at the root of all chemical phenomena, and it differs between the various elements to an extraordinary degree. As a rule, those elements which the more closely resemble each other in their chemical habits have the least affinity for each other, while the greatest affinity usually exists between those which are most dissimilar. As an instance of varying chemical affinity, when sulphur is present in molten iron ferrous sulphide (Fe S) is formed, but if manganese be added manganese sulphide is formed. This is an instance where sulphur has a greater chemical affinity for manganese than for iron, so it liberates the iron and takes into combination manganese.

When two or more substances unite together by their chemical affinity and form an entirely different substance, chemical action is stated to have taken place. In many cases chemical action takes place when the substances are merely brought in contact, while in other cases it is necessary to expose the bodies to the influence of some external energy. In almost every case of chemical action taking place in foundry practice, it is due to the application of heat to the substances.

### Solutions of Solids in Liquids.

When a substance is stated to be in solid solution, it must be considered that the attractive force which binds the molecules of the solid together have been overcome by the liquid—no chemical change having

* Abstract of Paper read before the London Branch of the British Foundrymen's Association, October 22, 1915, Mr. A Willis in the chair.

taken place. By raisng the temperature of the liquid more of the solid is enabled to be held in solution. When a saturated solution of a solid in a liquid is cooled, the dissolved solid begins to deposit itself out of the liquid, and it does so in most cases in definite geometric shapes, termed crystals. Solids which exhibit no crystalline structure are said to be amorphous.

The effect of dissolved substances in lowering the solidifying point of the solvent was first discovered by Blagden (1788) who formulated the law that the depression of the freezing point of aqueous solutions of the same substance was proportional to the strength of the solution.

### Combustion.

Combustion may be defined as the chemical union of two substances taking place with sufficient energy to develop light and heat. In all processes of combustion it is customary to regard one of the substances taking part in the chemical change as the combustible and the other as the supporter of combustion. Usually that substance which surrounds or envelops the other is called the supporter of combustion. During the process of combustion a certain amount of heat is evolved and a certain temperature is attained—these are quite two distinct results. The *temperature* is measured by thermometers or pyrometers, while the *amount of heat* is measured in terms of the calorie or heat unit.

The amount of heat produced by the combustion of any substance is the same, whether it burns rapidly or slowly, provided always that the same final products are formed in each case. In the former case, *i.e.*, rapid or active combustion, the action is completed in a few minutes or seconds, and as all the heat developed is evolved in this short space of time, the temperature of the substances rapidly rises, whilst in the latter case the heat is given out slowly, so slowly that it is conveyed away by conduction and radiation as fast as it is produced, and consequently the temperature of the material undergoes no perceptible change.

As the temperature produced by combustion is augmented by increasing the rapidity with which the chemical action takes place, it will be at once obvious why substances which burn in the air burn with greatly increased brilliancy and with higher temperature in pure oxygen. In the air every molecule of oxygen is surrounded by four molecules of nitrogen; therefore, for every one molecule of oxygen that comes in contact with the burning substance, four molecules of this practically inert element nitrogen strike it and prevent the contact of so much oxygen in a given time.

The temperature to which a substance must be raised for combustion to take place is called its ignition point. Every combustible substance has its own ignition temperature.

When both the substances taking part in combustion are gases or vapours, the sphere of the chemical action assumes the character of flame; while on the other hand, if one of the materials is a solid which is not volatile at the temperature of its combustion no flame accompanies its burning. Such solids as wax, phosphorus and sulphur, during combustion in air, undergo vaporisation, and consequently burn with the formation of flame; while such a substance as carbon, which does not pass into vapour at the temperature produced by its combustion in oxygen, burns in oxygen or air without giving rise to a flame. Under certain conditions the combustion of carbon in oxygen is accompanied by flame, but that is when carbon monoxide is being formed first and is afterwards burnt to carbon di-oxide. This forming of carbon mon-oxide is always the cause of bad results from the cupola, that is, if good fuel is being used. The colour of the flame of CO burning in air is a rich blue.

### Expansion of Gases, Liquids and Solids.

When a gas is heated, the pressure being constant, it increases in volume to the same extent, whatever the gas may be.

*Charles's Law.*—The volume of a given mass of gas, kept at a constant pressure, increases by a definite fraction of its amount at 0 deg. for each degree rise in temperature. This fraction is called the coefficient of expansion of the gas, which is about 1/273. Therefore, a gas heated to the temperature of 273 deg. will expand to double its original volume at 0 deg.

*Boyle's Law.*—The volume of a given mass of gas is inversely proportional to its pressure, temperature kept constant.

Different liquids and different solids have different expansions.

### Pressure in Moulds.

The intensity of pressure in a fluid is the same in all directions and at all points, at the same level beneath the surface, if the liquid is at rest; and the pressure on any horizontal surface is equal to the weight of a volume of the liquid represented by the area of the surface multiplied by the depth below the level of the surface of the liquid. This holds good whether the actual weight of the liquid be there or not. In other words, molten metal has the power to transmit pressure to every part of the mould into which it is poured; and each part of the mould (when it is full) sustains a pressure equal to the weight of a column of the metal reaching from such part to the upper surface of the runner basin or gate head. To demonstrate this action of pressure, reference may be made to the accompanying sketches:—

Fig. 1 represents a plain bar 1 in. square and 12 in. long. If metal is poured into this mould to the depth of 1 in., it is plain that the weight of 1 cub. in. of the metal is the pressure which the bottom surface of the mould must resist, and it is equally evident that the pressure on the bottom surface will be twelve times that amount when the mould is full. Also each of the four sides of the bottom inch must bear the whole pressure, so long as the metal is in a liquid state. The pressure at each 1-in. graduation ascending decreases by exactly the weight of 1 cub. in. of the metal; therefore, the pressure at each mark equals the weight of the column of the metal 1 in. square reaching to the surface, which would be roughly ¼ lb. per inch when considering iron or brass.

Fig. 2 represents a 12-in. cube which is divided into 12 equal layers of 1 in. thick, 12 in. square. It will be now evident that the pressure on the bottom surface of the mould, when the same is filled, will be the weight of 12 by 12 by 12 sq. in. of the metal, and the pressure on each side of the mould when full (assuming, of course, the metal is in a liquid state) will vary at different depths of the mould; for instance, the pressure at 1 in. in depth will be the weight of 12 cub. in. of the metal (this means, of course, across the whole side), and increasing by just the weight of an additional 12 cub. in. at each inch down to 12 in. Therefore the average pressure on the whole side will equal six times 12 cub. in. of the metal.

Fig. 3 represents a mould B which is connected with the running gate A, at the bottom. If the pressure at X (which is equal to the weight of a column of the metal the depth and magnitude of the runner A) were not transmitted to every square inch of the molten metal in the bottom of the mould, it would be impossible to fill it by this method. But such being the case, the mould gradually fills until the level of the runner is reached at Y; this conclusively proves that the whole of the liquid metal in the mould is balanced by the one square inch contained in the running gate, the pressure of which is transmitted to every square inch on the bottom of the mould and pressing upward as well as downward, sustains the whole mass at a level common with itself. Assuming now that the running gate is extended through the top part of the moulding box which is covering the mould, and is 12 in. deep, and bearing in mind that the pressure arising from the weight of liquid metal is proportional to its depth, and that the pressure is transmitted in every possible direction, it follows that, because the increase of depth in the running gate is exactly doubled, the pressure inside the mould will be in the same ratio when the runner is full to the top. As soon as the mould is full, it at once begins to exert a pressure upwards against the top part, increasing until the runner is full. The amount of upward pressure against the top part will be exactly the weight of a column of liquid metal whose magnitude is equal to the mould and whose depth equals the depth of the running gate from the upper surface of the mould to the top of the gate. This will be the case irrespective of the size of the runner. The depth of the mould below the lifting surface does not affect the pressure against the top part; this pressure is just the same whether the mould be 1 ft. or 1 in. thick.

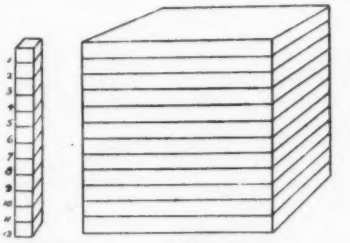


Fig. 1.



Fig. 2.

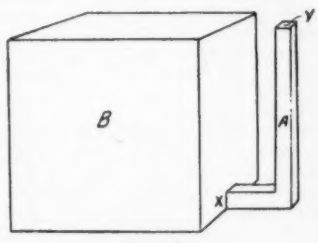



Fig. 3.

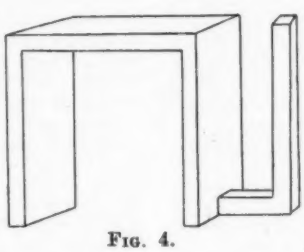


Fig. 4.

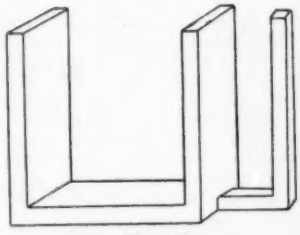


Fig. 5.

Figs. 4 and 5 require considering together, as they represent the same mould, only one being inverted to demonstrate the difference in "lift" or upward pressure. Fig. 4, when considered under the same conditions as Fig. 3 has been, will have the same "lift" or upward pressure as Fig. 3, but Fig. 5 will have a much increased upward pressure owing to the increased depth from the base to the top of runner.

### Discussion.

In the course of the discussion which followed, Mr. J. Neil asked whether the effect of a large quantity in the runner head was not to keep the scum out of the casting. Also, would gases given off by the ganister of the furnace have any influence in hardening the iron.

Mr. Aitken replied that the method of running largely governed the deposition of scum in the casting; there was little chance of scum rising through to the head against the flow of metal. He did not consider the ganister would have the influence suggested. Hardness of the metal might result from oxidation of the silicon from the metal or the presence of excess of sulphide impurities. If the cupola bed were damp, the water on being dried out would rise through the metal and decompose, the oxygen thus liberated oxidising the iron.

Mr. W. Ellis remarked that he had found that very hot iron strained the moulds more than dull iron. Mr. Aitken replied that the reason was that hot metal was more fluid and therefore had freer motion, whereas sluggish metal did not permit the natural distribution of pressure to come into play so readily.

A Visitor suggested that the rate of pouring would give increased pressure, a flow of high velocity giving greater pressure than slow pouring. With this suggestion Mr. Aitken concurred.

Mr. A. R. Bartlett, commenting on the lecturer's remark respecting a damp cupola bed causing hard iron, remarked that no good cupola man would charge iron until the bed had been properly dried.

Mr. Aitken said it was not a question of whether the cupola bed coke was alight; if it were not alight all over and the blast were put on, portions would blow cold and the blast instead of increasing combustion in those areas would do harm. There was considerable difference in the appearance of the tuyeres with large and small cupolas respectively, and a man accustomed to one might be misled as to the condition of the bed when dealing with a cupola to which he was not accustomed. If the bed coke was not properly alight, part of the blast would go "searching" instead of encountering lighted fuel and assisting combustion.

Answering a question as to the best heights for the tuyeres and the charging hole in a 3 ft. dia. cupola, Mr. Aitken said the height from bottom to tuyeres could be 12 in. with economy, but care in operation was necessary, and many foundrymen preferred greater space. The height to the charging hole should be 4½ to 5 times the diameter of the cupola.

Mr. Hall asked whether a well in the bottom of the cupola would serve any good purpose, with the object of taking the first cold metal. Mr. Aitken and other members, however, expressed the view that it would serve no purpose and would be dangerous. In most foundries there was some class of work to be cast which could take the first metal.

The meeting concluded with a vote of thanks to the lecturer.

# Ferro-Carbon-Titanium in Iron.

The following notes are taken from a pamphlet issued by the Titanium Alloy Manufacturing Company (represented in this country by Messrs. T. Rowlands & Company, Limited, North Church Street, Sheffield):—

Titanium is one of the elements, a silver-white metal having a steely fracture; it is brittle when cold, but may be drawn and forged at a red heat. The specific gravity of titanium is 4.50. In nature it always occurs in combination with oxygen alone, or with oxygen and other elements. In point of stability no other known compound surpasses the dioxide of titanium. The great stability of this compound is one of the characteristics which makes titanium available for metallurgical work.

While the dioxide of titanium is practically the only form occurring in nature, many other useful and interesting combinations can be made, but to make them requires the expenditure of great energy to break the stable combination of titanium with oxygen. The new forms of titanium thus produced are relatively unstable, and, therefore, revert under favourable conditions to the oxide. In the chemical process of reversion—or the reforming of the oxide—the energy absorbed in the formation of special titanium compounds is again liberated in the form of heat, and the chemical reactions are very energetic.

Metallic titanium forms alloys with other metals, some of which are useful in the arts. For example, an alloy of titanium and iron may be used as a deoxidiser in the purification of steel. The compound of titanium which most deserves our attention, because it is at the present time the most useful, is the carbide of titanium, occurring in combination with iron, in the form known commercially as ferro-carbon-titanium. It should be noted that the 80 per cent. ferro-manganese of commerce is a double carbide of manganese and iron. Carbide of titanium is formed only at very high temperatures and with the expenditure of great energy.

At lower temperatures titanium carbo-nitride or cyano-nitride may be formed if both carbon and nitrogen are present during the reduction of the oxide. Thus at the temperature of the blastfurnace, even though titaniferous iron ore forms a large proportion of the burden, comparatively little titanium is reduced, the pig-iron seldom carrying over 1 per cent. titanium. The titanium in pig-iron is probably present partly as carbide and partly as cyano-nitride.

Ferro-carbon-titanium is made by reducing titaniferous iron ores in the electric arc furnace, and under the conditions there prevailing—strongly reducing atmosphere and extremely high temperature—both iron and titanic oxides are reduced forming metallic iron and carbide of titanium. At the high temperature of the electric arc furnace with a reducing atmosphere and with excess carbon present the nitrides of titanium are dissociated, and hence are found only in traces in the product. While in the molten state in the electric furnace the titanium carbide is probably in complete solution in the iron; upon cooling, the titanium carbide separates in minute crystals uniformly disseminated in a manner entirely analogous to the separation of graphite from a solution of iron carbide in iron.

Titanium carbide heated to redness in the air or oxygen reacts quite as vigorously with oxygen as does metallic titanium, and likewise reduces oxides with which it comes in contact. It is this property of titanium carbide that imparts to the ferro-carbon-titanium its great efficiency as a cleanser of iron and steel.

This material is used to supply to the bath of iron an element which acts on oxygen, nitrogen. oxides, nitrides, or slag, forming with them compounds which readily separate from the iron and, due to their lower gravity, rise to the surface, leaving a clean metal. Its effect on grey iron is, by reducing oxygen, nitrogen, oxides, and nitrides, invariably present in blown metal, to eliminate the formation of blowholes. By oxidation titanium is converted into titanic oxide ($TiO_2$), which will act as a flux on the slag always found in suspension in iron, producing a clean, uniform, close-grained metal that may be easily machined. Foundrymen must not expect, however, that ferro-carbon-titanium, or any other deoxidiser, will eliminate defects due to moulding difficulties.

In semi-steel the effect is practically the same as in grey iron. In a comparatively hard metal, such as semi-steel, titanium is particularly beneficial in causing a uniform distribution of the sulphides.

In malleable cast iron the use of the material is still in the experimental stage. An addition of titanium is similar to one of silicon, namely, it will transform combined carbon into graphitic. While acting as does silicon so far as the carbon is concerned, titanium will be oxidised into $TiO_2$, which will pass completely away, fluxing the slag, while silicon, by oxidation, will be transformed partially into $SiO_2$ and partially into iron silicate, the latter a brittle compound.

In account of the action of titanium on carbon only small percentages of ferro-carbon-titanium are used; ordinarily from one-fourth to one-half ounce per hundred pounds of metal is sufficient to obtain the beneficial effect of its cleansing action without changing the form of the carbon in the iron. Some users employ small percentages of ferro-carbon-titanium in powdered form.

Ferro-carbon-titanium dissolves in iron at comparatively low temperatures. By its cleansing action in eliminating slag inclusions, weak spots and blowholes, titanium will increase the strength of the mixture used—it will thus give to each of the constituents of the mixture its maximum efficiency. Comparative test bars poured from the same mixture will usually show an increase in transverse strength of approximately 15 per cent. for the titanium treated bars.

As previously stated, it is a scavenger fluxing off all particles of occluded slag, thereby giving a very fluid metal and one which retains its heat longer and cools more slowly in the mould. This, in conjunction with the exothermic, or heat-producing, action of titanium in iron permits thin castings to be poured at lower temperatures than with untreated iron, thereby materially lessening the liability of the formation of shrinkage cracks. The material does not harden castings. On account of the increased denseness of treated iron it will however, resist abrasive wear to a much greater extent than an untreated metal of a more spongy character. Neither, however, does it soften castings, though it removes the hard spots so often found in iron and thus gives uniformity to the whole casting.

Where the metal is to be treated in a receiving or other ladle holding 1,000 pounds or more, previous to the opening of the taphole of the cupola, ferro-carbon-titanium (foundry grade) is scattered along the spout. For this purpose is furnished a tin cup holding two

pounds. When the cupola is tapped, the stream of iron carries the ferro-carbon-titanium into the ladle, thoroughly mixing it with the iron. One or two minutes should elapse between the time of tapping and the pouring of the iron into the first mould. This time allows the titanium to react completely on the oxides and gases occluded in the metal and also gives an opportunity for the particles of slag which will be fluxed by the titanic oxide to rise to the surface of the ladle. If any ferro-carbon-titanium is noted floating on the surface, the use of an iron stirrer will quickly dissolve it.

It is recommended that after each heat tapped from the cupola, or as often as may be necessary, the slag be skimmed from the top of the ladle, for if this slag is allowed to remain it will coat the titanium and prevent its dissolving.

Where metal is to be treated in hand ladles, the ferro-carbon-titanium (foundry grade) is placed in the bottom of the empty ladle and the iron poured on top of it. If it is not dissolved completely, the metal should be stirred with an iron rod.

Where the powdered form of material is used, the practice of wrapping the powdered titanium in small paper packages before it is introduced into the ladle is a very efficient means for making additions, although many prefer to use a spoon for the purpose.

For ordinary cleansing purposes from 2 to 4 lbs. per ton of iron is recommended; and for castings in which a particularly close-grained metal is desired, from 4 to 6 lbs. per ton.

## Queries.

### Cracking of Roll Castings.

*Reply.*—I do not think the fault is in the iron, but in the way the mould is made. In the sketch given in the query in your last issue (Fig. 1), there is only one down runner; in Fig. 2 herewith there are two separate down runners, and the first in-gate different to that shown by the enquirer's sketch. Both the down-runners are in one top runner-box

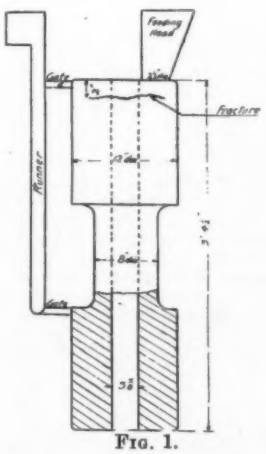



Fig. 1.

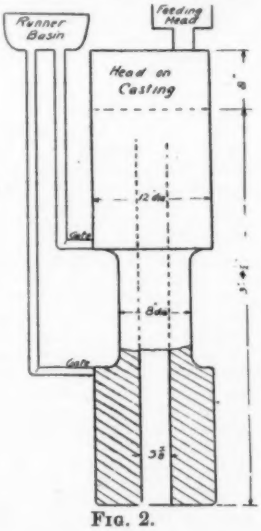



Fig. 2.

with a stopper on each hole. By lifting the long down-runner first and then, when the metal in the mould has got up above the other gate, lifting the second stopper and keeping the head well up, better results should be got. My sketch shows an 8-in. head on the casting with a feeding head above, which will have to be turned off. I always put a head on rollers, and it is very seldom I see one come back that has had fair treatment. They are cast as hot as possible. The feeding should take longer than the 15 minutes mentioned in the query with a casting so thick. The feeding hole should be kept open longer and supplied with plenty of hot feeding iron. Instead of facing sand, core sand should be used, as it is much better for rollers that are dried in the stove. Also, instead of blacking with plumbago I black with a blacking put on with a swab; then the sand comes off like cakes, and leaves the casting clean. I am making rollers in an ordinary pinned box, with bars top and bottom, off a pipe pattern in halves. The mixture for core sand is as follows:—12 spades of red sand, 5 spades of old black sand, 2 spades of water sand, 3 spades of horse droppings, half spade of coal dust; grind in mill 20 minutes after all the ingredients are in. The mixture for blacking is:—One pint of core gum, 4 full buckets of Ruabon blacking (from Evans & Company), 2 full buckets of plumbago. This is washed on all the skin-dried moulds—no rubbing of plumbago in and then washing. A camel-hair brush is used and the blacking is made a little thinner for the rollers, as it will not leave the brush when thick.

"A. S."

The trouble of cracking appears to result from the position of the top gate. The metal falling down the runner would first pass in by the lower gate, and the casting would be bottom-poured until the top gate was reached, and would carry any sullage on its surface to that point, while also being considerably cooled on reaching there; but at that point the metal would receive a flow from the top gate to complete the pouring, and this would tend to trap any deleterious matter at about the point where the fracture occurs, leaving it weak. The wedge-shaped head shown would accentuate the strain by resisting the pull of the casting while shrinking. There is no advantage in a head of this shape. A better feeding effect would be got by extending the casting to form a head, though that would have to be turned off.

"A. H."

## "F.T.J." Bookshelf.

**The Brass-Moulder** (Illustrated). By Alex. Purves. (London: E. & F. N. Spon, Limited, 57, Haymarket. Price, 3s. net.)

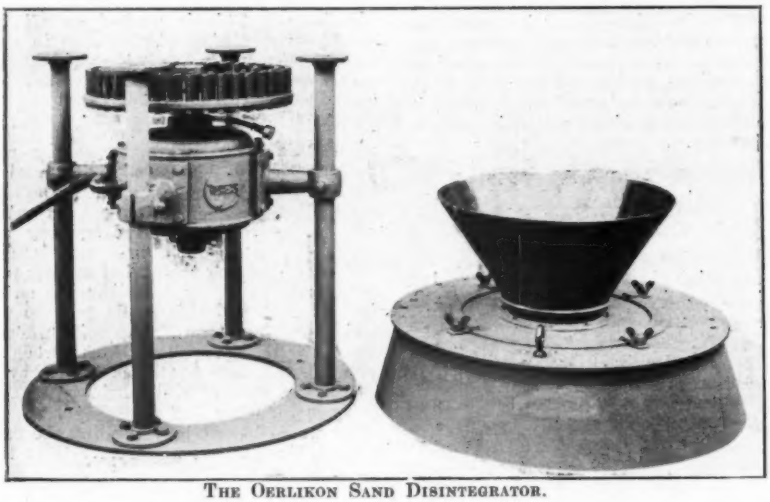
This is a little book of 165 pages, including 85 illustrations, offered as a practical guide for the apprentice and young journeyman. The author writes with all the directness and simplicity of an experienced moulder, and gives many valuable hints as to methods and practice generally. Writing from the moulder's standpoint, of course, the purely metallurgical side of brass founding is not treated, but a number of practical examples of moulding jobs are followed up to the point of receiving the metal. While there is much in brass founding that is not touched upon by the author, his notes will be appreciated by the apprentice and young journeyman who like simple instruction straight from a practical man.

The Minister of Munitions has made an Order dated October 1, under Section 4 of the Munitions of War Act, 1915, declaring 264 additional establishments as controlled establishments under the Act, as from October 4, 1915. A total of 979 establishments have now been declared as controlled.

## A Swiss Sand Disintegrator.

Owing to the exclusion of Germany from the world's markets at the present time, an opportunity is afforded such countries as Switzerland to push their own manufactures in many directions. The Swiss are not hampered by the lack of labour for trade expansion which operates with belligerent countries, and having access to all neutral markets and those of the Allies, they are making good use of the opportunity. The British Government, for example, has placed considerable orders with Swiss firms which would in ordinary circumstances have gone elsewhere. Since Switzerland possesses a considerable engineering industry, it is not surprising to find Swiss machinery now being offered to British users.

An example in point is the apparatus illustrated herewith—a centrifugal disintegrator for foundry work, made by the Oerlikon Company, the British, Irish and Colonial Department of which is under the management of Mr. G. Würtrich, M.I.E.E., Oswaldestre House, 34-35, Norfolk Street, Strand, W.C.



THE OERLIKON SAND DISINTEGRATOR.

The general construction of the apparatus will be seen from the illustration, which shows the cover and sand receiver removed. The base is an iron ring and four pillars support the outer casing and also the vertical electric motor which rotates the disintegrator discs with the pins. The motor is completely enclosed and dust-proof, and operates from an ordinary lighting circuit by a flexible cable.

The following are particulars of the apparatus:—

| | With D.C. Motor. | With 3-phase Motor |
|---|---|---|
| Height of apparatus .. | 4 ft. | 4 ft. |
| Diameter of apparatus .. | 3 ft. | 3 ft. |
| Motor .. .. .. | 2 h.p. | 2 h.p |
| Maximum pressure .. | 220 volts. | 500 volts. |
| Revolutions per minute .. | 960 | 960 |
| Weight complete .. .. | 685 lbs | 600 lbs. |
| Sand per minute treated .. | 6 to 10 cwts | 6 to 10 cwts. |

The sand is shovelled into the hopper of the machine and the rapid revolution of the disc on which it falls flings it towards the periphery and against the three rows of staggered pins, effectively breaking it up. The sand then falls from the flange of the hood in a heap around the apparatus. Pieces of iron, which cannot pass the pins, collect in the centre of the disc, whence they can be gathered on removing the cover.

It should be noted that no special foundation is needed for the apparatus.

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**INTERNAL-COMBUSTION MOULD DRIER.**—A drier for large moulds, in which an internal-combustion burner is employed in conjunction with a pressure blower to furnish the heated air used, has been placed on the market by the H. M. Lane Company, of Detroit, Mich., U.S.A. This device is an adaptation of the Crawford internal combustion burner, and is intended as a substitute for the practice of burning gas jets in the mould. Among the advantages claimed are that there are no ashes to handle or solid fuel to deliver, while by reason of the relatively high pressure carried in the combustion chamber the hot gases can be delivered at points a considerable distance from the machine and the high velocity in the pipes minimises the radiation losses and enables air to be forced into the pockets in the mould. The drier consists of a standard 6-ft. burner mounted on a base and provided with a pressure blower and gas connections. The blower is driven by a motor located on the end of the frame, the electric current being taken through a flexible cord from an electric light socket and controlled by a switch suspended from the air pipe in the centre of the machine. Swaged couplings are employed between the blower and the relief valve, with a view to providing an air chamber to equalise the pulsation of the blower. In operation the gas comes through the hose from the supply main and passes through the mixer, where air is added to it. From here it enters the burner pipes which pass into the top and bottom of the combustion chamber. The gas from these pipes is burned in jets, the flames impinging against the auxiliary air pipe entering the end of the burner. This pipe has lateral nozzles through which auxiliary air is blown into the combustion chamber with a view to reducing the temperature of the products of combustion. These and the auxiliary air pass down and out through four pipes 2 in. in diameter, to which are coupled a series of pipes to reach any part of the mould. The flame is controlled to maintain the outgoing gases at a temperature of approximately 800 deg. F.

# Adding Phosphorus to Metals and Alloys.

By Walter J. May.

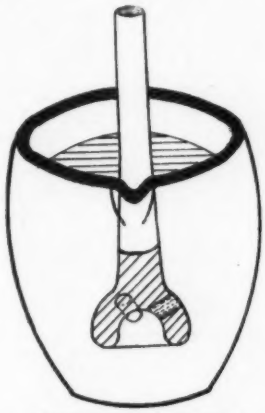
Quite apart from the effect of phosphorus on metals, the question of its introduction often presents difficulties which are at times a source of much trouble to the operator. As the introduction of the agent and the reactions it produces very often cause dense fumes to arise, it is a very general practice to introduce it into the crucible while still in the furnace, so that the minimum of unpleasantness is caused, and this possibly is the better method where the fire is kept under good control. In many cases the reaction produces a rise in temperature of the metallic bath, and this should be considered at all times, because with too great an increase of heat the effect of the introduced agent may be decreased, or even nullified, and generally it is desirable that the work shall be done as soon as the metal in the bath assumes the molten state.

From a working point of view it is always necessary that any addition of the kind indicated shall be done in a reducing atmosphere, and in regard to this a few precautions are required. The crucible should never be more than three-fourths full of molten metal, and there should be a layer of granulated charcoal over the surface of the metal (blacking is not desirable), the charcoal preferably being about the size of peas. In the majority of cases a layer of charcoal about half an inch in thickness is ample, while in most cases a large proportion of that skimmed off the metal is recoverable for use again. Another important point is that the agent, in whatever form used, should be passed to the bottom of the molten metal and be quite submerged, otherwise vaporisation is likely to remove much of the active portions and thus reduce the efficiency of the quantity charged. To place anything on the surface of molten metal usually results in only a partial reaction, while with many things the mere burning away of the stuff occurs without the molten metal being in any way affected.

The form in which phosphorus or other addition is introduced to the bath of metal often depends on personal preferences, but as a rule when alloys of a definite percentage are obtainable they are preferable to the crude material. Phosphorus can be had alloyed with iron, copper, or tin, and if in making, say, phosphor-bronze in which 1 per cent. of phosphorus has to enter, phosphor-tin having a content of 15 per cent. P be used, it will be found that 6¾ lbs. will hold enough phosphorus, but generally 7 lbs. would be used, the mixture for a tough bronze being 93 lbs. copper and 7 lbs. 15 per cent. phosphor tin. However, a lower percentage of phosphorus would be effective if the copper were clean and of good quality. In one case recalled by the writer 89 lbs. copper and 11 lbs. tin were alloyed together, and then 17½ ozs. crude phosphorus added, the effect not being good; but when the phosphorus was added to the copper before the tin was alloyed the effect was good, more probably since half the phosphorus escaped, as the amount was excessive for the purpose intended, 0.5 per cent. being ample for the class of metal dealt with. Of course, red phosphorus was used and dried in the ordinary way, an iron tube or "phosphorus stick" being used, this adding much iron to the bronze.

In making and mixing alloys it is often desirable that iron should not come in contact with the molten metal, this at times causing difficulty. Plumbago stirrers are used as a matter of course, but these do not cover every requirement, and usually recourse is had to the ordinary iron phosphorus tube coated with plumbago wash, which is a very indifferent makeshift for the purpose. To provide a better appliance for alloying work the "Salamander" plunger has been devised, and the accompanying rough sectional sketch shows the salient points of the device. The head of the plunger is hollow, and has three holes through the upper portion which permits of the metal or other material circulating through it, and when the plunger is lifted up and down in the crucible the metal is forced through the head and very efficient mixing is caused.

Apart from its use in the addition of phosphor-tin in making phosphor-bronze and the like, the plunger is useful for adding metals of small specific gravity to others of considerable weight, because the dry,



Plunger in Crucible.

warm, light metal can be placed in the head of the plunger and held well under the bath of molten metal with which it is to be alloyed until it is melted, mixing being then effectively secured by working the plunger up and down in the metal. Where alloys are likely to stratify during melting and pouring the use of the plunger occasionally will keep them well mixed.

As the plunger is made of a plumbago mixture something of the same nature as the crucibles, it conveys no metallic impurities to the molten metal. It is about 18 in. long before the attachment for the iron rod is reached.

In the case of powdered material having to be used, it should be wrapped in thin paper before being placed in the plunger, and when at the bottom of the metal a gentle up-and-down motion should be used to cause its disengagement, as in some cases it might fuse and not permeate the metal in the way intended. Phosphorus should be dried and rolled in paper before being added to metal, as most persons know, and some metals which have a more or less violent reaction should be treated in the same way.

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## Reclaiming Brass Sweepings.

By A. W. Lemme.

In a Paper presented before the Chicago Foundrymen's Club recently, Mr. A. W. Lemme, of the Chicago Bearings Metal Company, described the method and equipment adopted by his firm for reclaiming brass sweepings. The works in question has a melting capacity of about 100,000 lbs. of metal per day, involving an accumulation of from 12,000 lbs. to 15,000 lbs. of refuse per day. The refuse is dumped in one pile in the yard and the largest pieces of metal picked out by hand. The rest is then put through a large screen of 1 in. mesh, and that portion of the refuse which goes through the 1 in. mesh is put through a crushing process.

The crusher is run by a 35-h.p. motor, and is washed by a water process. The two wheels of the crusher are about 4 ft. in diameter, with a 10-in. face, weighing about 6,000 lbs. each, running in a pan 18 in. deep and about 10 ft. in diameter. The crusher is sunk in the floor, the top of the pan being on the floor level, making the feeding of the pan easy. The pan is fed some 30 min. steadily, the crusher stopped and the heavy brass shovelled out of the pan into a jig consisting of a 14-in. square pan with a brass screen of 100 mesh in the bottom. The water agitates through the screen and through the brass. The brass is then shovelled out and the iron picked out by hand. This brass product or "washings" is used direct.

Many fine particles of brass escape with the overflow of water passing through the jig screen, and this overflow, in conjunction with the overflow from the crusher pan, is led into a pit where a sand pump automatically conveys it to a concentrating table. These processes render useable four separations of refuse:—(1) The large pieces of metal separated by hand; (2) the washings; (3) the pieces that are too large to go through the 1-in. mesh; (4) the concentrate recovered by the concentrating table.

The first two separations are used directly in the foundry, the third is used in a cupola direct, and the fourth, the concentrate, which contains about 20 per cent. metals, is briquetted by using 90 per cent. concentrate and 10 per cent. of the very cheapest stucco (plaster of Paris). The briquettes are made by adding enough water to make the mixture a soft mud and shovelling it into forms which set quickly. Two men at 10d. per hour make 300 briquettes per 10-hour day.

In order to control the efficiency of the concentrating table, a chemical analysis of the tailings or of the refuse after the concentrate has been separated is taken. An average of 0.85 copper, representing 1.10 metal contents is found, and these tailings are analysed every 24-hour run. The washings recovered by the above process contain about 85 per cent. metal, as follows:—77 per cent. copper, 12 per cent. lead, 7 per cent. tin, and 4 per cent. zinc and impurities. Washings are also analysed daily.

The third and fourth separations of the refuse are treated in a 24-in. water-jacketed cupola. Measuring from the bottom to the tuyere holes, there is a straight wall 12 in. high and 24 in. in diameter, the slag hole being 6 in. above the metal hole. The cupola measures 10 ft. from tuyere holes to charging door and increases in diameter from 24 in. to 38 in. at the top. A 4-in. water-jacket surrounds the cupola between these points. The only brick lining in the cupola is between the bottom and the tuyere holes. The blast is furnished by a 6 ft. positive-pressure blower, and it is found that a pressure from 12 to 14 oz. gives the best results, holding the water in the jacket at about 100 deg. F. The charges are made as follows:—250 lbs. limestone, 380 lbs. refuse, 100 lbs. slag direct from cupola, 100 lbs. coke, and two buckets of water. The capacity of the cupola is about five of the above charges per hour.

The slag is tapped three times per hour and is held at the consistency of cream, not allowing it at any time to become sticky, as it is absolutely necessary to keep the slag thin enough for the metal to flow through it freely; otherwise a large portion of the metal would be carried off with it. The slag is tapped into trucks and set aside to solidify before emptying, after which each ball of slag is broken and inspected for metal, and a good-sized nugget is often found at the bottom.

A sample of the slag is poured into cold water once every hour, and one analysis is taken on each 12 samples. The sample is easily pulverised and dissolved. The average analysis is 0.97 copper, 43.50 silicon dioxide and 22.60 metallic iron. Two taps of slag are generally taken to one tap of metal, bringing down from 8 to 12 ingots weighing about 25 lbs. each. One ingot is selected from each hour's run and a complete analysis is taken from the drillings of 12 ingots, thereby taking two complete analyses to each 24-hour run. The average analysis is 82 per cent. copper, 8 per cent. tin, 7 per cent. lead, and 2 per cent. zinc and impurities.

This little cupola has been run as long as 12 days and 13 nights without interruption. Great care must be taken in charging it, as it is small and tapered and is easily hung.

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**SILICIDISED CARBON-SILFRAX.**—At a recent meeting of the American Electro-Chemical Society a Paper was presented by Mr. F. J. Tone, of the Carborundum Company, on "Silicidised Carbon-Silfrax." When solid carbon is acted upon by vapours of silica or silicon there is formed a silicon carbide product of the same shape as the original carbon but differing from carborundum in essential characteristics. To distinguish this form of silicidised carbon commercially, it has been given the name of "silfrax." The properties and characteristics of the product vary with the temperature of formation. If the carbon article is heated in the amorphous zone of a carborundum furnace, the temperature range of this zone being 1,550 to 1,820 deg., the product is amorphous in appearance, showing no crystals except under high magnification. It has a yellow colour and a lustreless fracture. If the carbon is heated in the crystalline zone of the furnace, the temperature of this zone ranging from 1,820 to 2,220 deg., the material is of great density and plainly crystalline. Upon fracture it shows a steel-black colour and a metallic lustre. The depth of the silicidising action is mainly a function of the time of reaction and the concentration of silicon vapour present in the furnace atmosphere. To obtain the best conversion a large excess of silicon vapour must be present and the mixture should contain silica largely in excess of the theoretical carborundum mixture. Under regular conditions with articles of pure carbon the maximum penetration is about ½ inch. Articles composed of a mixture of carborundum and carbon can be readily converted to a greater depth. Chemical analysis of the two varieties made in the amorphous and crystalline zones show that both are silicon carbide and give no basis for regarding the products as new compounds of silicon and carbon. The commercial applications of silfrax are as refractory materials, electrical heating elements and chemical ware. It has all the chemical and heat-resisting properties of carborundum, and in addition great density and toughness. Pyrometer tubes are now made 24 in. in length, and by special furnace construction it will be possible to make much larger-sized articles for special refractory vessels and chemical apparatus.

## Non-Ferrous Notes.

**Volatilisation of Zinc.**—A source of considerable loss in some foundries lies in the volatilisation of zinc from molten brass. The fact that the loss varies in different foundries from a trifling amount to as much as 7 or 8 per cent. of the zinc content indicates that bad management is an influential factor in causing the loss. In foundries where the organisation is bad, it is no uncommon thing to see the zinc fumes pouring from a pot in the fire for some time after the metal is ready, simply because the moulds are not also ready. As a standing rule it should be laid down that metal should never wait for moulds, but instead moulds for the metal. To leave metal "soaking" in the fire is almost inevitably to oxidise it, unless the zinc content is high, in which case the loss of zinc is a sufficient objection. With high-copper alloys, such as Admiralty gun-metal, the effect of "soaking" is too well known to require more than passing reference.

**Stirring of Metals.**—Opinions appear to vary considerably as to the possibility of obtaining perfect homogeneity in a complex mixture without thorough stirring. Most alloys, however, if not all, are improved by proper stirring prior to melting, though care must be taken not to do this so vigorously as to expose excessive surface of the hot metal to the atmosphere. It should be remembered, also, that the oxides of some metals are of nearly the same specific gravity as the metal itself, and to stir such dross into the metal just before pouring often involves trapping it in the casting. Oxide of aluminium is a case in point; and in dealing with this metal it is better to secure proper mixing by making a primary alloy of the additions with small quantities of the aluminium and adding the necessary portion of that alloy to make the mixture. It is hardly conceivable that metals with such different specific gravities as copper and aluminium can properly mix, except under excessive agitation, when simply melted down together.

**Barium.**—Although the metal Barium itself is light, its specific gravity being 3.6, or about half that of tin, its compounds are all heavy. It is a bright yellow metal, and belongs to the group of alkaline earth metals which comprise calcium, strontium, and barium. It is a very energetic deoxidiser. The metal is obtained by the reduction of its chloride by metallic sodium. The sodium is formed into an amalgam by mercury and is then added to a hot saturated solution of barium chloride. The sodium leaves the mercury and combines with the chloride to form common salt, and the liberated barium metal unites with the mercury to form barium amalgam, which is afterwards washed to remove any traces of sodium, and is then heated in an atmosphere of hydrogen to remove the mercury by volatilisation. This is an expensive way of obtaining the metal, and on that account it is not likely that it will be used in non-ferrous metallurgy until a cheaper method of production is perfected.

**Burning-in of Cores in Bronze Work.**—The only sure way to prevent heavy masses of bronze cast around comparatively small cores from eating into the core is to give the latter a coating of refractory material sufficiently thick to resist the heat and pressure of the metal. A paste of real plumbago and molasses water rubbed on to the core, giving it a smooth, shiny coating of sufficient thickness to entirely hide the sand, is one method. After the paste has been applied, the core is re-dried and is ready to be inserted in the mould. The hole from such a core is generally very clean.

**Silicon-Copper.**—The principal use of the alloy known as silicon-copper is a deoxidiser for copper. It reduces the electrical conductivity of the copper to which it is added, but is applicable for all copper castings in which the property of high conductivity is unimportant. The addition of 1 per cent. of a 10 per cent. silicon-copper to molten copper reduces the conductivity of the latter to about 57 per cent. This adds a little less than 0.10 per cent. silicon to the copper, because a "10 per cent." alloy usually contains a little under that amount of silicon. Thus a very small amount of silicon makes a big difference in the electrical properties of the copper, in which respect it is more powerful than aluminium, as the latter element when added in the same proportion to copper only reduces the conductivity 23 per cent. In brass and bronze, silicon-copper is not largely used, and then not in alloys containing lead, because it combines with the latter metal to form a silicate, which is deposited in the form of a white powdery substance on the outside of the casting, giving them a white coating, and also collects in little pockets and streaks making the castings rough and pitted. Silicon is used to a limited extent in yellow brass when it contains no lead, and exerts much the same effect as aluminium, as it prevents smoke and gives fluidity. It does not dross so badly as aluminium.

In making silicon copper, ferro-silicon of 95 per cent. silicon and 5 per cent. iron is used. It comes in bright shining chips of a bluish-purple colour. The alloy should be broken into small grains, and either added to the molten copper gradually with stirring, or the copper can be granulated and arranged with the ferro-silicon in alternate layers in the cold crucible, and the whole melted down together in a very hot furnace. The latter is probably the best method. To make the 10 per cent. alloy, 12 per cent. of 95 per cent. ferro-silicon, and 88 per cent. of granulated copper are used. When the charge is thoroughly molten, the mass should be vigorously stirred with a graphite stirrer; the crucible removed from the fire and contents poured into ingots. The resulting alloy should be very brittle, and of a silvery colour. Care must be used in handling the alloy, or nasty cuts may result. When made in the manner stated the analysis will show about 9.85 per cent. silicon, with iron about 0.3 per cent.

**Smoke-blacking of Moulds.**—The blacking of moulds for brass casting by means of smoking them has long been practised, but the apparatus used is frequently very crude. At the works of the Yale and Towne Manufacturing Company, Stamford, Conn., U.S.A. (the makers of the well-known Yale locks), some of the dried moulds are finished by blacking with rosin smoke and some of the green-sand moulds also are treated in the same way. For this purpose two special blacking machines have been installed. The moulds are supported around the periphery of the machine in a circle, and the rosin pots are carried on a frame work which rotates underneath. A hood is provided over the apparatus to carry away the smoke; it is connected to an electrically-driven exhaust fan to insure a positive ventilation.

**Manganese-Copper.**—Manganese is best added to copper alloys in the form of a Cu.70-Mn. 30 alloy, this rich alloy being used for introducing the manganese into the copper alloy. The manganese and copper are melted together in a crucible at a heat sufficiently high to melt manganese. The mass is then well stirred and poured out into small bars, which may be readily cut into pieces. This manganese-copper alloy is added in the proportion of about 5 ozs. to 100 lbs. of molten metal. The manganese acts as a deoxidiser, and promotes soundness in the castings, and an excess appears to do no harm.

## Trade Talk.

THE PORTUGUESE GOVERNMENT has issued an order prohibiting the export of wolfram ore from that country.

MR. GEORGE ALEXANDER has opened a showroom at 84, Coleshill Street, Birmingham, for the display of American machine tools.

THE adjudication of W. A. A. Burrows, engineer and machinist, carrying on business at 33, Talbot Street, Derby, has been annulled.

MR. C. H. RATHBONE, iron and steel agent, has transferred his offices from 65, Lichfield Street, Wolverhampton, to 14, New Street, Birmingham.

THE GLASGOW COMMITTEE constituted to deal with the question of the export of steel and articles made from it have granted up-to-date 1,945 certificates.

M. E. ASPINALL, trading as Joseph Aspinall and Company, engineers and ironfounders, at Bella Street, Daubhill, Bolton, has been adjudged bankrupt.

CONSIDERABLE damage was done by a fire which broke out on October 14 at Messrs. Marshall, Fleming & Company's Dellburn Engineering Works, Motherwell.

MESSRS. ARDEN HILL & COMPANY, of the "Acme" Gas Stove Works, Birmingham, have appointed Mr. W. Hoe as their northern agent, with headquarters at Manchester.

A FIRST dividend will shortly be paid by the liquidator of P. A. Mitchell & Company, Limited, engineers, Edinburgh, Glasgow, and 101, Leadenhall Street, London, E.C.

MESSRS. S. HOPKINSON and H. W. RILEY, general pattern makers, Crown Works, Princess Street, Huddersfield, trading as Mann and Hopkinson, have dissolved partnership.

THE firm of John M. Collins & Son, engineers, etc., Ruby Street, Bridgeton, Glasgow, has been dissolved by the retirement of Mr. John Collins. The business will be continued by Mr. J. M. Collins under the same style.

THE COUNCIL OF THE ASSOCIATION OF CHAMBERS OF COMMERCE has decided to seek from the Ministry of Munitions information as to the rate of depreciation to be allowed on new plant installed in factories for the making of munitions of war.

THE directors of Walker, Maynard & Company, Limited, in their annual report just issued, state that owing to the high cost of coke it was impossible to manufacture pig-iron without loss, and the company's furnaces were consequently blown out in July last.

THE partnership heretofore subsisting between Messrs. J. Hawkins, C. Hawkins, and G. H. Furmedge, carrying on business at the Severn Engineering Works, Tybridge Street, Worcester, under the style of C. Hawkins & Company, has been dissolved.

THE partnership heretofore subsisting between Mrs. C. M. Ashton, as executrix of the late H. M. Ashton, and F. B. Holt, carrying on business as electrical and general engineers, at 15, Cross Street, Ryde, I.W., under the style of Ashton & Holt, has been dissolved.

THE shareholders of the Preston Engineering Company, Limited, will meet at 59, Chancery Lane, W.C., on November 8, for the purpose of having an account laid before them, showing the manner in which the winding-up has been conducted and the property of the company disposed of.

THE firm of Stevenson & M'Guffie, carrying on business as consulting, mechanical and electrical engineers, at 163, Hope Street, Glasgow, has been dissolved by the retirement of Mr. D. W. M'Guffie. The business will be continued by Mr. H. A. M'Guffie under the same style.

THE partnership heretofore subsisting between Messrs. W. Pickard & T. Heap, carrying on business as engineers, under the style of the Broadfield Engineering Company, at Pilsnorth Road, Broadfield, Heywood, has been dissolved. The business will be carried on in the future by Mr. Heap.

WITH reference to the manufacture of munitions in North Wales a board of management has been appointed and approved by the Ministry of Munitions, of which Mr. William Buckley, of Hafod, Mold, has been elected as chairman and Mr. H. A. Tilby, clerk to the Flintshire County Council, is secretary.

THE average price of West Coast hematite warrants for the quarter ended September 30 having been 95s. per ton, the wages of Cumberland furnacemen under the sliding scale will be for the ensuing quarter 60¾ per cent. above the standard. The average for the corresponding quarter of last year was 61s.

UPWARDS of 800 names are inscribed on the fine repoussé bordered brass and copper panel provided by the Workington Iron and Steel Company, Limited, and unveiled at the Workington Public Library, by the Mayor (Mr. P. Walls), as a memorial of the employés of the company who have volunteered for service at the Front.

THE GLASGOW DEAN OF GUILD COURT has sanctioned plans of Barclay, Curle & Company, Limited, to erect a building at the Clydeholm Shipbuilding Yard; of David Rowan & Company, engineers, to erect additional buildings at 231, Elliott Street; and of Thomas McIvin & Sons, Limited, St. Rollox Ironworks, to erect additions to their works.

IN his presidential address to the Birmingham Association of Mechanical Engineers on October 1, Mr. A. E. A. Edwards criticised the present system of training engineers. Three features of an engineer's training, he said, did not usually receive sufficient attention—the commercial side of the business, the control of men, and the power of speech.

THE partnership heretofore subsisting between Messrs. S. C. Birks and J. Yates and L. A. Whitham, carrying on business as iron and brass founders, at Livesey Street Foundry, Padiham, under the style of Yates, Whitham and Birks, has been dissolved, so far as regards Mr. S. C. Birks. Messrs. J. Yates and L. A. Whitham will continue the business under the style of Yates and Whitham.

THE sixtieth session of the Manchester Association of Engineers was opened on October 9 with an inaugural address by Mr. Sam Boswell, the president, on "Ancient and Modern Engineering—Comparisons, Reflections and Tendencies." Previous to the address the Constantine gold medal was presented to Mr. Frank Foster, M.Sc., for his paper on "Essential Principles of Engine Design, and Materials of Construction."

MR. T. M. AINSCOUGH, the special commissioner appointed by the Board of Trade to enquire into the conditions and prospects of British trade in China, has now returned to this country, and is prepared to interview representatives of British firms who may be able to see him at the offices of the Commercial Intelligence Branch of the Board of Trade. Applications should be addressed to the Director of the Commercial Intelligence Branch.

ACCORDING to the official ascertainment the average net selling price of No. 3 Cleveland pig-iron for the months of July, August, and September was 64s. 0.54d. per ton, as compared with 58s. 7.30d. per ton for the previous quarter. Under the sliding scale arrangements the wages of blastfurnacemen are advanced by 6.75 per cent., making the present wage of 33.25 per cent. above the standard 40 per cent. above the standard. The advance dates from October 2.

REPRESENTATIVES of the French Commission on the supply of steel for munition purposes held a conference last month, at Swansea, with representatives of the Welsh steel makers, when a discussion took place on the requirements of the former. These

were stated to be upwards of 5,000 tons of shell rounds per week. An executive committee was formed to make the necessary arrangements, it being agreed to assist the Commission in every possible way. The Commissioners afterwards visited works in the district.

Appeals by William Beardmore & Company, Limited, against the valuation of their works in Rigby Street and Hart Street, Glasgow, have been considered by the Burgh Valuation Committee of Glasgow. The Assessor's valuation on the Rigby Street works was £3,000, and on the Hart Street works £2,500. Appellants pleaded that the figure should be £1,250 and £500 respectively. It was agreed that the question of the valuation of these works should be delayed until the making up of the supplementary valuation roll in February and March next.

An additional furnace has been lighted at the Old Side Works, at Workington, of the Workington Iron and Steel Company, Limited, and is working on spiegel. Another furnace is in preparation for lighting at the Derwent Works, the object being to keep four there in full blast. It is stated that the Solway Ironworks at Maryport, the property of the Workington Iron and Steel Company, will be restarted in the near future. One furnace was put out in October, 1913, and the works have been standing idle since January, 1914, when the other furnace was damped down. It is also understood that the Derwent Mills will be restarted.

The question of the production of spelter has been considered by the Council of the London Chamber of Commerce, and a resolution has been adopted which will in due course be submitted to the Government. The resolution asks the Government to grant a bonus for not less than 20 years on spelter produced at works in Great Britain having an Empire origin when the average monthly price falls below £23 per ton, the bonus to be granted on the same month's output to raise the price to £23. Alternatively, it is proposed that the State should guarantee interest on the capital invested in such works. They arrived at the price of £23 after hearing evidence from the Australian producing companies, consumers and merchants.

In order that every available works may be utilised in the manufacture of munitions, a committee of nine members of Tees-side engineering firms, together with a board of management approved by the Minister of Munitions, has been appointed to organise the production of shells in a number of works which have spare lathes, etc. The board of management is as follows:—Mr. T. W. Ridley (chairman), Mr. W. Hawdon, Mr. T. H. W. Chambers and Mr. F. P. Wilson. The committee is composed of the board of management and the following other members:—Mr. A. F. Pease, Mr. Francis Samuelson, Mr. Arthur Cooper, Mr. L. F. Giers, Mr. G. Ritchie, Mr. C. J. Bagley, Mr. T. Westgarth, Mr. R. J. Worth, and Mr. H. B. Tov. The activities of the committee will cover Middlesbrough, Darlington and Stockton.

The Australian Federal Attorney-General has postponed for a month or so the establishment of the Australian Metal Exchange at Melbourne. All metal transactions, however, must be registered with the Attorney-General. His Majesty's Trade Commissioner for Australia writes that "In prescribing rules for the projected Exchange the Attorney-General has definitely declared that a 'British firm' is to be defined as one all the partners of which are natural born British subjects, and approved by the Federal Attorney-General. A 'British company' is defined as meaning a company incorporated in the British Dominions, all the directors of which are natural-born British subjects, and at least four-fifths of the shareholders of which are British subjects resident in the British Dominions. At least four-fifths of the capital of such company must be owned by British subjects, and the company must not be mainly controlled, directly or indirectly, by the subjects of any foreign country."

The Technical Committee of the Society of Motor Manufacturers and Traders and the Institute of Automobile Engineers, have decided to form a committee to undertake certain steel research, on which committee representatives of the Admiralty and War Office will serve. The Society has guaranteed £1,000, and the Government are contributing a similar sum. Members have already subscribed a good proportion of the £1,000, the list of subscribers including the Daimler Company, Limited, Sunbeam Motor Car Company, Limited, Wolseley Motors, Limited, John I. Thornycroft & Company, Limited, Albion Motor Car Company, Limited, British and Colonial Aeroplane Company, Limited, J. & E. Hall, Limited, Humber, Limited, John Marston, Limited, D. Napier & Son, Limited, J. Samuel White & Company, Limited, Handley-Page, Limited, Rudge-Whitworth, Limited, Standard Motor Company, Limited, W. L. Stewart & Company, Limited, Bristol Tramways and Carriage Company, Limited, Halley's Industrial Motors, Limited, White & Thompson, Limited, Bowden Wire, Limited, Dover, Limited, and the Hoyt Metal Company of Great Britain, Limited.

The Monometer Manufacturing Company, Limited, Whitehouse Street, Aston, Birmingham, have lately booked a large number of orders for their Monometer furnaces, the purchasers including many motor-car companies, tramways companies and corporations, who utilise the furnace for melting white metals for lining bearings and for heating the moulds preparatory to lining. Among these buyers are the Daimler Motor Company, Limited, of Coventry; the Lanchester Motor Company, Limited, Birmingham; the Sheffield Corporation Tramways, and the India Rubber Gutta-Percha and Telegraph Works Company, Limited, Silvertown. Johnson & Phillips, Limited, have now installed one of these furnaces together with the Monometer patented low-consumption burners for lead presses. The company's system of melting aluminium without crucibles and without oxidation still progresses, the authorities at Woolwich Arsenal having ordered a 2-300 lbs. capacity furnace of the ladling type, and one of 500 lbs. capacity fitted with ten of the Monometer reversible ingot moulds. Roneo, Limited, of Romford, the Manchester Aluminium Company, of Manchester, and the Wolverhampton Metal Company have also placed orders for this type of furnace.

## Contraband of War.

A Proclamation has been issued revising the list of articles to be treated as contraband of war. The order, which is dated October 14, makes certain further additions to and amendments in the lists issued in December, 1914, and March, May, and August, 1915, and in future the articles enumerated in Schedule I. will be treated as absolute contraband.

Schedule I. includes:—

Implements and apparatus designed exclusively for the manufacture of munitions of war, or for the manufacture or repair of arms or of war material for use on land or sea.

The following metals:—Tungsten, molybdenum, vanadium, sodium, nickel, selenium, cobalt, hematite pig-iron, manganese, electrolytic iron, and steel containing tungsten or molybdenum.

Aluminium, alumina, and salts of aluminium; antimony, together with the sulphides and oxides of antimony; copper, unwrought and part wrought; copper wire; alloys and compounds of copper; lead, pig, sheet, or pipe; tin, chloride of tin, and tin ore.

Ferro-alloys, including ferro-tungsten, ferro-molybdenum, ferro-manganese, ferro-vanadium, and ferro-chrome.

## Deaths.

CAPTAIN OSWALD BAMFORD, a partner in Messrs. Bamford's, Leighton Ironworks, Uttoxeter, has been killed at the front. Captain Bamford was 36 years of age.

CAPTAIN WILLIAM McLÆOD McMILLAN, Argyll and Sutherland Highlanders, chairman and managing director of Arch. McMillan & Son, Limited, has been killed in France. The deceased gentleman was 40 years of age.

MR. J. M. NEILL, eldest son of Mr. James Neill, The Croft, Carsick, Sheffield, has died in his twenty-sixth year, consequent upon a long illness following a serious motor accident. The deceased gentleman was connected with the firm of Messrs. James Neill and Company, of the Composite Steel Works, Napier Street, Sheffield.

THE death is announced of Mr. George Spencer Knight, J.P., at the age of 56 years. The deceased was the principal of Messrs. Mills & Knight, engineers and boilermakers, of 155, Fenchurch Street, London, E.C., and Bermondsey Wall, and Rotherhithe, S.E. During practically the whole of his career he was connected with the firm, serving an apprenticeship in his father's yard, becoming manager of the firm, and taking over the full control in 1907 upon his father's death.

LIEUTENANT JOHN GORDON HOLLINGSWORTH, son of Mr. A. T. Hollingsworth, of 2, Belsize Grove, Hampstead, London, N.W., has been killed in action at the Dardanelles. He was born in 1884, and after leaving school was trained at the Seafield Park Engineering College, at University College, London, and in the works of Plenty & Sons, Limited, and Henry Bessemer & Company, Limited. Later he joined the staff of our contemporary, "Engineering," and for several years had been a director of the company.

MR. A. TROPENAS, inventor of the Tropenas converter, who died recently at Lyons, France, at the age of 55 years, was in the early part of his career a foreman at the works of the French Brugès firm where he was in charge of the Robert converter. Later he came to this country to superintend the installation of the same converter at the works of Edgar Allan & Company, Limited. While there he invented his own converter, which he patented both in Great Britain and the United States. About 14 years ago he went to the States to introduce his process there.

INFORMATION has been received at Sheffield of the death in action in Flanders of Captain John Lockwood Marsh, 1-4th (Hallamshire T.) Battalion York and Lancaster Regiment. He was the elder surviving son of Mr. Harry Parker Marsh, of Broomgrove House, Sheffield, a former Lord Mayor of the city. Captain Marsh, who was 31 years of age, was educated at the Sheffield Grammar School and Uppingham. After leaving school he spent a year and a half in Germany, and six months in Paris, returning home to become a director and secretary of Marsh Brothers & Company, Limited, Ponds Steel Works, Shude Lane, Sheffield.

MR J. E. MADDOCK, of Easterfield, Wellington, head of the firm of Messrs. John Maddock & Company, Malleable Ironworks, Oakengates, died recently. Mr. Maddock was 61 years of age, and died from pneumonia after three days' illness. A little over twelve months ago Mr. George Maddock, of Wolverhampton (brother) died, and during the last six months two other brothers connected with the firm, Mr. Fred Maddock and Mr. Charles T. Maddock, both died. These family bereavements, combined with the responsibility of conducting the works at Oakengates, where about 500 hands are employed, were a great strain on the deceased gentleman. He was one of the most popular men in the Midland iron trade.

WE regret to announce the death of Sir Andrew Noble, Bart., which took place on October 22, at his Scottish residence, Ardkinglas, Argyllshire, at the advanced age of 84 years. By his death Newcastle loses one who for well over half-a-century played a part in the building up of the vast Elswick works of Sir W. G. Armstrong, Whitworth & Company, Limited, and of the numerous and widely scattered enterprises promoted by the firm. During his long career, Sir Andrew worked unceasingly, and until age and infirmities compelled him to refrain from taking a full share in the management of Elswick he was in the closest possible touch with every part of the company's immense ramifications. Sir Andrew Noble was born at Greenock on September 13, 1832, his father being in the Royal Navy. He was educated at the Edinburgh Academy, and at the Royal Military Academy, Woolwich. In 1849 he entered the Royal Artillery, and was promoted to the rank of captain in 1855. He was appointed secretary of the R.A. Institution in 1857; secretary of the Committee on Rifled Cannon in 1858, and of

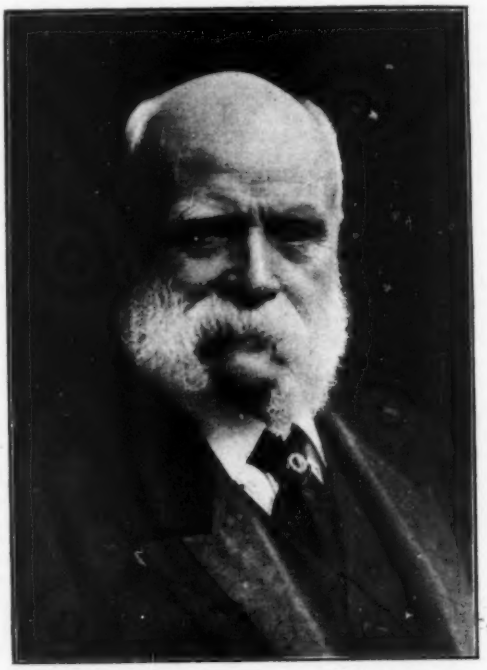


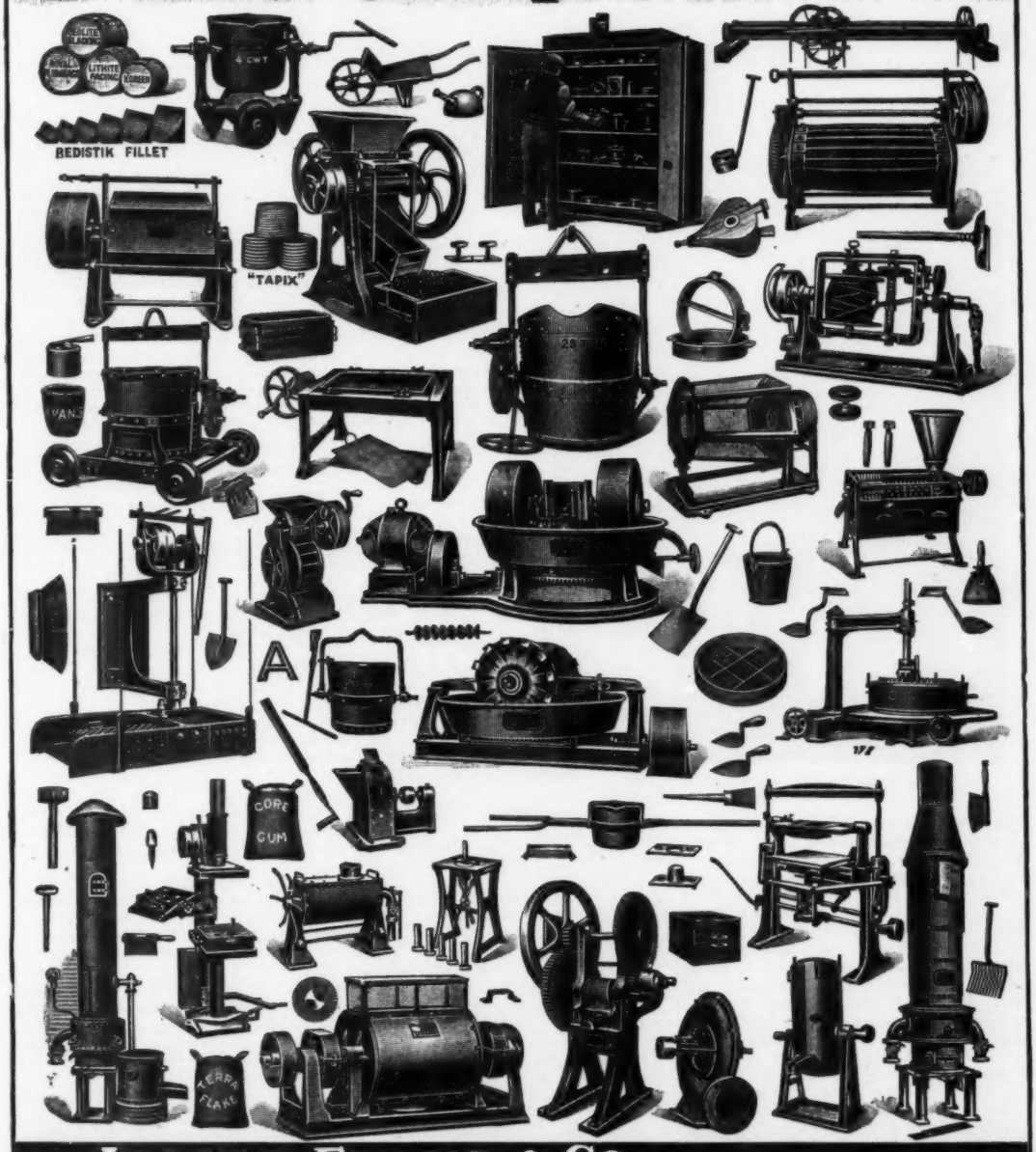
*Photo* *Elliott & Fry.*
THE LATE SIR ANDREW NOBLE, BART.

the Committee on Armour Plates and Guns in 1859. In the following year he received the appointment of Assistant Inspector of Artillery; and was made an associate member of the Ordnance Select Committee. He was also a member of the Committee on Explosives from its formation. It was in 1860 that the deceased first became connected with Newcastle and Tyneside by joining the firm of Messrs. Armstrong at Elswick, and for some years prior to his retirement in 1911 practically managed the great industrial enterprise there. Just as the inception of the Elswick works was due to the late Lord Armstrong, so their progress and development have been due to Sir Andrew's energy and enterprise. His early training was invaluable to Lord Armstrong. The Elswick Works were established in 1847 mainly for engineering purposes, but Lord Armstrong's experiments with guns induced him to add the ordnance department, now of international fame. Sir Andrew was a Fellow of the Royal Society, the Royal

COMPLETE

# Foundry Equipment.

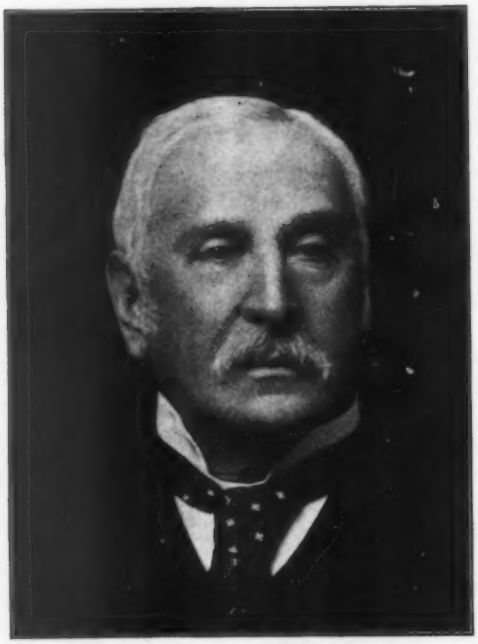
Telegrams: "LADLES" MANCHESTER
Telephone: "No 2297 CENTRAL" MANCHESTER




JAMES EVANS & Co. BRITANNIA WORKS, BLACKFRIARS. MANCHESTER.

Astronomical Society, and the Chemical Society; Honorary Member of the Institution of Civil Engineers, Doctor of Science of the Universities of Oxford and Cambridge, Doctor of Civil Law of Durham University, Foreign Member of Academa del Iincei, Rome. He held the gold medals of the Royal Society and the Society of Chemical Industry, and the Albert medal of the Royal Society of Arts. He was a Baronet and K.C.B., and had received numerous foreign orders.

We regret to announce the death of Col. T. E. Vickers, C.B., at his London residence, 12, Stanhope Place, W., in his 82nd year. The deceased gentleman had been in failing health for several months. Colonel Vickers was born in 1833, and came of old Sheffield stock. His forefathers had taken a leading place in Sheffield trades, though in their day nothing so enormous as the firm of Vickers, Limited, was ever considered practicable. It is considerably over one hundred years since the foundations of the firm were laid by Mr. Naylor, grandfather of Colonel Vickers.



The Late Col. T. E. Vickers, C.B.

The firm first carried on business under the style of Naylor and Sanderson, who were merchants and manufacturers. Their establishment was in Sheffield, and the concern was successful, but in 1829 the partnership was dissolved, and out of it came two new firms, the first being Sanderson Brothers & Company (still an important Sheffield concern), and Naylor, Hutchinson, Vickers & Company. Of the latter firm Mr. Edward Vickers, father of Colonel Vickers, was one of the partners. Eventually three other sons of Mr. Edward Vickers became partners, and at Millsands a growing trade was carried on until 1864. A branch was also started in America, with the object of sharing in the commerce of that rapidly developing country, and this proved a successful venture. In 1864 the concern was transferred to Brightside. Colonel Vickers started business immediately on completing his education. The first portion of his school days was spent in Sheffield; afterwards he was for a considerable time in Germany. It was on his return from Germany that he went to the firm of Naylor. Hutchinson, Vickers & Company, and when but 22 years of age he was called upon to take control of the establishment, a position he filled with great ability. He had not been long at the works before he saw that the Millsands establishment was altogether inadequate for the business which was now developing so rapidly. A site for new works was secured at Brightside, where now stand the River Don Works. The controlling power of Colonel Vickers was seen and felt on every hand. He introduced large improvements from time to time in the plant, found fresh methods for producing castings and forgings, and added almost every new appliance which was likely to be of benefit to the firm. The twenty acres at first covered by the River Don Works were soon extended, until over sixty acres were taken up. Thirteen years after Colonel Vickers entered the firm, the first marine shaft was made. Four years later the first propeller was cast by the firm; the first forging press was put down in 1882; the first armour-plate officially tested in 1888; the first Vickers' guns were fired in 1888; and but a few years later shipbuilding and marine engineering works were added to the firm's multiplicity of undertakings. To-day, Vickers, Limited, have establishments in many places besides Sheffield, and as years advanced the responsibility on the shoulders of Colonel Vickers, chairman of the company, increased. With a view to achieving even greater things the firm acquired the Naval Construction Works at Barrow, which to-day are amongst the best equipped establishments of the kind in Great Britain. The amalgamation with Maxim's followed, and the arrangement with the Maxim Nordenfeldt Gun and Ammunition Company placed at the disposal of Colonel Vickers and his colleagues valuable works at Erith, Birmingham, and elsewhere. By means of these arrangements, Vickers, Sons, and Maxim (the name by which the firm was known for a number of years, until recently) were eventually in the unique position of being able not only to build a battleship but also to equip her for immediate service.

## Personal.

The late Mr. E. T. Beardshaw, a director of J. Beardshaw & Son, Limited, Baltic Steel Works, Sheffield, left estate of the gross value of £7,851.

Mr. C. Arthur Head has resigned from the board of Walker, Maynard & Company, Limited, and Mr. W. E. Walker, jun., has joined His Majesty's forces.

Mr. W. H. Ellis, managing director of John Brown & Company, Limited, of Sheffield and Clydebank, has been re-elected master of the Cutlers' Company of Hallamshire.

Second-Lieutenant J. D. Beswick, who has been wounded at the front, is a member of the firm of Messrs. John Warner & Sons, engineers and ironfounders, of Hanley.

Mr. T. Zeitz, who recently retired from the Board of Kayser, Ellison & Company, Limited, has been succeeded by Mr. P. B. Henshaw, who has been of very great service to the company for the last twelve years.

Lieut-Col. H. G. Ley, of Willington House, Derbyshire, who until the war broke out was vice-chairman of Ley's Malleable Castings Company, Limited, Derby, is in command of the 1st Nottinghamshire and Derbyshire Yeomanry, recently formed, and now with the Expeditionary Force.

Mr. J. W. Danks has been appointed steelworks manager at the Dowlais works of Guest, Keen & Nettlefolds, Limited, in place of Major Jenkins, who has become the manager of the Wishaw Works. Mr. Danks held a similar position at the works of the Barrow Hematite Steel Company, Limited.

Mr. A. C. Dinkey has resigned the presidency of the Carnegie Steel Company, the largest single unit of the United States Steel Corporation, to become president of the Midvale Steel and Ordnance Company, of Philadelphia, the formation of which recently took place. Mr. Dinkey's successor as president of the Carnegie Steel Company will be Mr. H. D. Williams.

USE

T. ROWLANDS & Co., LTD.
SHEFFIELD.

British & European Agents for:
TITANIUM ALLOY COMPANY.
U.S.A.

FERRO CARBON TITANIUM
TPC BRAND

For Sound Steel and Iron Castings.

DELIVERIES FROM STOCK.

IRON CASTINGS.
"FOUNDRY GRADE."
STEEL CASTINGS.
"E GRADE."

THE "LEEDS" PORTABLE MOULD DRIER.

SELF CONTAINED.

ELECTRICALLY OPERATED.

This handy appliance has proved itself in use to be thoroughly satisfactory in drying out Moulds of every description, whether in boxes or in the floor. It is economical in coke, can be started from cold in 10 minutes, and requires very little attention. Owing to the induced draught no dirt or dust is blown into the Moulds. The entire apparatus can easily be handled by two men.

OTHER LABOUR SAVING FOUNDRY APPLIANCES.

ROTARY CORE MACHINES.

DEAD LENGTH CORE MACHINES.

HAND PRESS MOULDING MACHINES.

HORACE P. MARSHALL & CO.,
LEEDS.

Telegrams:—"Specialty, Leeds."
Telephone:—1909.

## Parliamentary Notes.

**Excess Profit Tax.**

The Chancellor of the Exchequer has informed Mr. G. A. Touche that as regards the Excess Profits Tax the special appeal tribunal will be competent to deal with any question of increasing the rate for the percentage standard as regards any trade or industry for which, as a class, six per cent. is *prima facie* inadequate.

**Henry R. Merton and Company, Limited.**

In the House of Commans, October 26, Sir Henry Dalziel asked what were the relations between the firm of Messrs. Henry R. Merton & Company, Limited, and the Admiralty; and whether that firm had been entrusted to negotiate on behalf of the Government for the purchase of supplies of material or commodities.

Mr. Macnamara was understood to reply that the company were not and never had been engaged as metal brokers for the Admiralty, but since the outbreak of war had supplied 2 tons of aluminium notch bar from the Broken Hill Proprietary Company, Limited. In October, 1914, the company were also employed to secure a large consignment of copper which was distributed for use on Government work. Mr. Gardiner, a director of the company, had from time to time given his services to the Government and advised them on several matters in regard to the metal trade in which his expert knowledge was of considerable value.

Sir Henry Dalziel asked the Minister of Munitions to state the extent of the transactions which his Department have had with Messrs. Henry R. Merton & Company, Limited, and whether, in view of the recent judgment of the Prize Court regarding a cargo of zinc concentrates per the steamship "Bilbster," it was intended that his Department should have any further dealings with that firm.

Mr. Lloyd George: Three purchases of metal have been effected through Messrs. Merton & Company since the Ministry was formed, and they have been invited on several occasions to tender, along with others, for various metals, but have not recently secured any orders on their tendering. I am in communication with other Departments concerned with respect to future relations with the firm and in regard to the judgment referred to.

Sir Henry Dalziel asked the Solicitor-General whether, in view of the judgment of the Prize Court in connection with the case of Messrs. Henry R. Merton & Company, Limited, regarding the cargo of the steamship "Bilbster," he would state whether it was proposed to take any action in the matter.

Sir F. E. Smith: The Director of Public Prosecutions has decided, after consultation with myself, that it is not desirable to take further action in this matter.

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**STEEL SURFACE HARDENING WITH MANGANESE FLOUR.**—Metallic manganese in the form of a powder, known as manganese flour and containing 98.5 per cent. manganese and free from carbon, is now being successfully used for facing steel castings which in service require a soft steel centre and a very hard surface, such as certain parts of rolling mills, cement mills, grinding and crushing machinery, dredging buckets, etc. The manganese flour is mixed with linseed oil to the consistency of a wash and then applied to the mould to a depth of 1-16th to ¼ inch. Silica wash is applied as usual before the manganese. The mould is then baked and the steel poured, the manganese being absorbed on the surface. On cooling, the surface of the casting is said to be so hard that it cannot be machined. The carbon from manganese used for the purpose was introduced by the Thermit Company.

## New Companies.

**Ormskirk Munitions, Limited.**—Capital £5,000 in £10 shares.

**Betts' British Foil Factories, Limited.**—Capital £75,000 in £1 shares.

**Stainless and Rustless Steel Company, Limited.**—Capital £1,000 in £1 shares.

**Manchester Metal Stamping & Engineering Company, Limited.**—£5,000 in £1 shares.

**Shells (Rochdale), Limited.**—Capital £6,000 in £1 shares. Registered office:—John Street, Rochdale.

**Herbert Widdowson & Sons, Limited.**—Capital £6,000 in £1 shares, to carry on the business of ironfounders.

**The Leeds Munitions Company, Limited.**—Capital £20,000 in £1 shares. The subscribers are R. Dolby (London) and W. Farrier (Leyton).

**T. Browning & Sons, Limited.**—Capital £7,000 in £1 shares, to carry on the business of ironworkers, etc. Registered office: Canterbury Road, Whitstable, Kent.

**Henry Lowe & Sons, Limited.**—Capital £8,000 in £1 shares, to carry on the business of mechanical engineers. Registered office:—Downey Ironworks, Royston.

**Annealers, Limited.**—Capital £1,000 in £1 shares, to carry on the business of theraml treaters of metals, annealers and hardeners of steel, etc. Secretary: Mr. G. Oates.

**Noble Engineering Company, Limited.**—Capital £5,000 in £1 shares (3,500 "A" and 1,500 "B"). Registered office:—44-50, Hercules Road, Westminster Bridge Road, S.E.

**Oldfield & Schofield Company, Limited.**—Capital £20,000 in £1 shares, to carry on the business of engineers. Registered office: Central Iron Works, Boothtown, Halifax.

**C. E. C., Limited.**—Capital £5,000 in £1 shares, to carry on the business of electrical and general engineers. Registered office: 96, Ironmonger Row, Old Street, London, E.C.

**Walter & Company (Steel), Limited.**—Capital £2,000 in £1 shares, to carry on the business of iron and steel manufacturers, etc. Registered office: Exchange Buildings, Stephenson Place, Birmingham.

**Harvey & White, Limited.**—Capital £100 in £1 shares, to carry on the business of iron, brass and general founders, etc. Mr. H. C. Harvey is the first director. Registered office:—10, Union Passage, Birmingham.

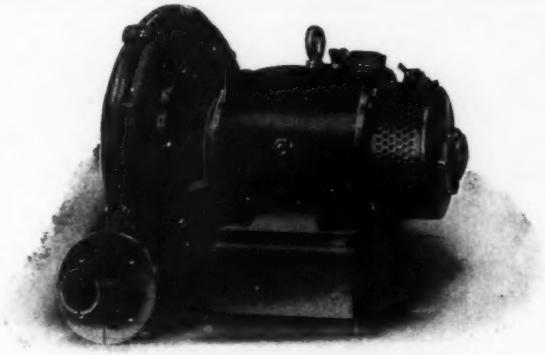
**Jones Brothers (Preston), Limited.**—Capital £4,000 in £1 shares, to take over the business of engineers and boilermakers carried on by H. Jones, J. H. Jones, and J. Jones at Bold Street, Preston, Lancs., as Jones Brothers. Private.

**Anglo-American Metals Syndicate, Limited.**—Capital £3,000 in £1 shares (2,750 "A" and 250 "B"), to adopt an agreement with S. A. Yorks and J. O. Lawson Johnson. Registered office: Trafalgar House, Waterloo Place, S.W.

**Allied Metals Selling Company, Limited.**—Capital £1,000 in £10 shares, to carry on the business of importers and exporters of, agents for, dealers in and manufacturers of all metals, etc. Registered office: 1, Church Court, Old Jewry, London, E.C.

**Chatwins, Limited.**—Capital £15,000 in £1 shares, to take over the business of ironfounders carried on by W. H. Chatwin, A. Chatwin and Alfred Chatwin at the Market Foundry, Tipton, as Thomas Chatwin. The first directors are W. H. Chatwin, Arthur Chatwin and Alfred Chatwin.

**McAlpine Bros., Limited.**—Capital £10,000 in £1 shares, to carry on the business of metal founders and refiners, etc. The subscribers are: W. McAlpine, Cotton Lane, Birmingham; J. B. McAlpine, 17, Wal-



10 H.P. Fan and Motor.

TRADE SIROCCO MARK

## High Pressure Fans

Are made in a large number of sizes from 10 in. diameter upwards.

Bulletins 2000 F. and 2028 F.

## Some Points worth noting.

Owing to few wearing parts, the Fans are not liable to break down. The mechanical efficiency is high and remains so. The pressure is steady and the volume even and free from pulsations.

# Davidson & Co., Ltd.,

Sirocco Works,
BELFAST.

# ELDER'S FOUNDRY COKE

AS SUPPLIED TO THE
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ADMIRALTY DOCKYARDS.

**The following, selected from numerous letters, are eminent testimony as to the quality of our celebrated "A.A.A." Coppee Foundry Coke, carefully selected, and despatched in sheeted wagons.**

From PECKETT & SONS, Bristol.

Bristol, October 25th, 1901.

We have been using your Selected Foundry Coke for some considerable time. We have pleasure in stating that we are very pleased with it, as we find we get sounder and cleaner castings, more free from blowholes and other defects, than we formerly did.

From BOW, McLACHLAN & CO., LTD. (Paisley Foundry), Paisley, Glasgow.

Paisley, 12th March, 1909.

We have yours of 4th inst., and in reply have pleasure in stating that we have been using your Foundry Coke for several years for special purposes with highly satisfactory results.

# Celtic Collieries, Ltd., Cardiff.

Telegraph: "OUTPUT, CARDIFF." Telephone: 4640 & 4641.

lace Crescent, Ibrox, Glasgow. Registered office:—Princes Street, Govan, Glasgow.

**James Taylor (Bradford), Limited.**—Capital £5,000 in £1 shares, to take over the business of engineers carried on by J. W. Taylor and A. Taylor, as James Taylor, at 97, Osborne Street, Bradford. The first directors are J. W. Taylor and A. Taylor. Registered office: 97, Osborne Street, Bradford.

**United Metal Foundries, Limited.**—Capital £500 in 350 10 per cent. cumulative preference shares of £1 each and 3,000 ordinary shares of 1s. each. The first directors are T. Edwards (managing director), G. W. Merrifield, A. H. Bell, J. F. Pearse, J. C. Stansell, J. Field and H. Lutweche. Registered office:—233 and 235, Queen's Road, Battersea, London, S.W.

**Shorthose, Lee & Company, Limited.**—Capital £1,000 in £1 shares, to take over the business of bedstead manufacturers carried on at Hall Green Street, Bradley, Bilston, as Shorthose, Lee & Company, to carry on the same and the business of founders, engineers, etc. The first directors are:—A. Shorthose, Mrs. F. L. Shorthose and J. Lee. Registered office: Hall Green Street, Bradley, Bilston.

## New Patent Regulations.

An Order in Council has been issued amending the Defence of the Realm (Consolidation) Regulations, 1914, as set out below:—

After Regulation 18A the following Regulation shall be inserted:—

18B.—(1) Where an application has been made whether before or after the date of the making of this order, for the grant of a patent or the registration of a design in the United Kingdom, and the Comptroller-General of Patents, Designs and Trademarks is satisfied that the publication of the invention or design might be detrimental to the public safety or the defence of the Realm, or might otherwise assist the enemy or endanger the successful prosecution of the war, he may delay the acceptance of the complete specification filed with the application for the patent, or, as the case may be, the registration of the design, and in such case may by order prohibit:—

(*a*) the publication or communication in any way of the invention or design;

(*b*) application being made for the protection of the invention or design in any enemy or neutral country; and

(*c*) application being made for the protection of the invention or design in any allied country or in any of His Majesty's Dominions without the permission of the Admiralty and Army Council.

(2) No person shall apply for the grant of a patent in respect of any invention or the registration of a design in any foreign country, or in any of His Majesty's Dominions, unless he has left at, or sent by post to, the Patent Office, a notice of his intention, together with a provisional specification describing the nature of the invention or, as the case may be, a representation or specimen of the design, nor until after the expiration of one month from the time when such notice was given, and if during the said month the Comptroller-General is satisfied that the publication of the invention or design might be detrimental to the public safety or the defence of the Realm, or otherwise assist the enemy or endanger the successful prosecution of the war, he may make a like order as in respect of cases in which application is made for the grant of a patent or the registration of a design in the United Kingdom.

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(BIRMINGHAM SAND), Ltd.,
ICKNIELD SQUARE WHARF, BIRMINGHAM.
ESTABLISHED OVER A CENTURY.
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FOUNDRY SAND
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Also ROLL SAND of all descriptions ready for use.

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*Established 1863.*

# JAS. DURRANS & SONS,

## Phœnix Works, Penistone, Near Sheffield.

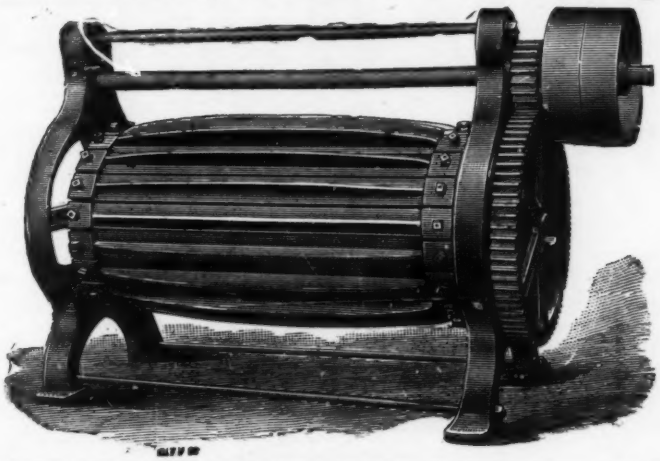
**Manufacturers of all**

## *FOUNDRY EQUIPMENTS*

**COMPOSITION BLACK LEAD, PLUMBAGO, CORE GUM, WHITE DUST & COAL DUST**

**Ladles, Cupolas, Fire Bricks, Gannister, Stone Flux, Loam and Sand Mills, Casting Cleaners, Studs, Chaplets, Pipe Nails, Sprigs, Brushes, Wire Brushes, Core Ropes, Bellows, Buckets, Spades, Forks, Riddles, Sieves, Barrows, Etc.**

## Improved Foundry Rattler or Fettling Drum.



**These Machines are invaluable for a Foundry, doing a larger amount of work of a superior quality, in a much shorter time than can be done by hand, without skilled labour.**

The following testimonial explains itself:—

"Dear Sirs,—We have been using your best Blacking for a large number of years, and always use it on our large Ingot Moulds, which, as you know, we have made up to 85 tons in weight.

Yours faithfully, THE BRIGHTSIDE FOUNDRY & ENGINEERING CO., LD.

# MONTHLY PRICE LIST.

**The undermentioned prices, unless otherwise specified, are those obtaining on the first day of the current month.**

## Pig-Iron.

### Cleveland.

| | s. | d. |
|---|---|---|
| Cleveland No. 1 | 72 | 0 |
| „ No. 3 | 68 | 0 |
| „ No. 4 foundry | 67 | 6 |
| „ No. 4 forge | 67 | 0 |
| „ Mottled | — | — |
| „ White | — | — |
| East Coast hematite, mixed Nos. | 110 | 0 |
| Cleveland warrants | 68 | 0 |

Above prices are for early f.o.b. deliveries and as regards Cleveland iron are for G.M.B. brands. The warrant quotations are the sellers cash prices.

### Scotland.

| | s. | d. |
|---|---|---|
| Standard Foundry (Glasgow Market settlement price) | 67 | 4½ |
| Warrants, ditto | 73 | 9 |

| Makers' prices:— | s. | d. | | s. | d. |
|---|---|---|---|---|---|
| Gartsherrie No. 1.. | 86 | 0 | No. 3.. | 86 | 0 |
| Coltness No. 1.. | 102 | 0 | No 3.. | 82 | 0 |
| Summerlee No. 1.. | 85 | 0 | No. 3.. | 80 | 0 |
| Langloan No. 1.. | 85 | 0 | No. 3.. | 80 | 0 |
| Calder No. 1.. | 80 | 0 | No. 3.. | 75 | 0 |
| Clyde No. 1.. | 86 | 0 | No. 3.. | 81 | 0 |
| Carnbros No. 1.. | 82 | 0 | No. 3.. | 78 | 0 |
| Monkland No. 1.. | 81 | 0 | No. 3.. | 79 | 6 |
| Shotts No. 1.. | 85 | 0 | No. 3.. | 80 | 0 |
| Govan No. 1.. | 75 | 6 | No. 3.. | 74 | 6 |
| (All deliverable alongside Glasgow.) | | | | | |
| Glengarnock No. 1 . | 85 | 0 | No. 3.. | 80 | 0 |
| (Deliverable alongside Ardrossan.) | | | | | |
| Dalmellington No. 1 | 82 | 0 | No. 3.. | 80 | 0 |
| Eglinton No. 1.. | 79 | 0 | No. 3.. | 78 | 0 |
| (Deliverable alongside Ayr.) | | | | | |
| Carron No. 1.. | 86 | 0 | No. 3.. | 81 | 0 |
| (F.a.s. Grangemouth.) | | | | | |

### Lancashire.

| | s. | d. | s. | d. |
|---|---|---|---|---|
| Lancashire No 3 foundry f.o.t. | — | | — | |
| Lincolnshire No. 3 foundry | — | | 71 | 9 |
| Derbyshire No. 3 foundry | 71 | 6 | 72 | 0 |
| Staffordshire No. 3 foundry | — | | 71 | 6 |
| Cleveland No. 3 foundry | 76 | 4 | 76 | 10 |
| (All delivered equal Manchester.) | | | | |
| Scotch No. 3 — Gartsherrie | — | | 86 | 0 |
| Scotch No. 3 — Glengarnock | 84 | 6 | 86 | 0 |
| Scotch No. 3 — Eglinton | — | | Nom. | |
| Scotch No. 3 — Summerlee | 85 | 0 | 86 | 0 |
| (Delivered Manchester Docks.) | | | | |

### North-West of England.

| | s. | d. | s. | d. |
|---|---|---|---|---|
| Bessemer mixed numbers net f.o.b. | — | | 117 | 6 |
| Hematite warrant net cash | — | | 100 | 0 |
| Lern cold-blast charcoal iron | — | | — | |

### The Midlands.

| | | s. | d. | s. | d. |
|---|---|---|---|---|---|
| Staffs. | Common forge | 65 | 0 | 66 | 0 |
| | Part Mine forge | 68 | 0 | 69 | 0 |
| | Best All Mine | — | | 130 | 0 |
| | Cold Blast | — | | 150 | 0 |

Strong forge, about 1s. less than grey forge; Mottled and White, about 2s. less than forge; Foundry No. 3, 3s. to 5s. above forge; No. 1 and No. 2, from 1s. 6d. to 2s. above No. 3; No. 1, about 2s. above No. 2.

| | | |
|---|---|---|
| Northampton foundry | — | — |
| North Staffs. foundry | — | — |
| Derby foundry | — | — |
| Nottinghamshire foundry | — | — |
| Leicestershire foundry | — | 73 0 |
| Shropshire Cold-Blast | — | — |

Delivered South Staffordshire Works, net cash monthly.)

### Lincolnshire.

| | s. | d. | s. | d. |
|---|---|---|---|---|
| Forge | — | | 65 | 0 |
| Grey forge | — | | 65 | 0 |
| Basic | — | | — | |
| No. 3 foundry | — | | 66 | 0 |
| No. 4 foundry | — | | — | |

F.o.t. Makers' works.

### South Wales.

| | s. | d. | s. | d. |
|---|---|---|---|---|
| Welsh Hematite | Nominal. | | | |

## Ferro-Alloys.

Net, Delivered Sheffield Steel works.

| | £ | s. | d. |
|---|---|---|---|
| Ferro-chrome: 4/6% carbon, Basis 60%, scale 10s. per unit. Per ton | 32 | 0 | 0 |
| Ferro-chrome: 6/8% carbon, Basis 60%, scale 10s. per unit. Per ton | 29 | 10 | 0 |
| Ferro-chrome: 8/10% carbon, Basis 60%, scale 8s. 6d. per unit. Per ton | 28 | 0 | 0 |
| Ferro-chrome: Specially refined, guaranteed maximum 2% carbon, broken to small pieces for use in best quality crucible steels. Basis 60%, scale 22s. per unit. Per ton | 80 | 0 | 0 |
| Ferro-vanadium: 33/40% Va., per lb. of Va. contained in the alloy | 0 | 9 | 6 |
| Ferro-silicon: 45/50%. Basis 50%, 5s. scale per unit Per ton | 24 | 0 | 0 |
| Ferro-titanium: 23/25%, per pound, carbonless | 0 | 1 | 6 |
| Ferro-molybdenum: 70/80% Mo. per pound of Mo. contained | 0 | 18 | 0 |
| Ferro-phosphorus: 20/25%. Per ton | 16 | 10 | 0 |
| *Ferro-manganese 80% | 20 | 0 | 0 |
| „ export | — | | |

* F.o.b. Liverpool.

## Iron Castings.

### Cleveland.

| | £ | s. | d. | £ | s. | d. |
|---|---|---|---|---|---|---|
| Columns (plain) | 7 | 7 | 6 to | 7 | 12 | 6 |
| Pipes, 1½ to 2½ in. | 7 | 5 | 0 | 7 | 15 | 0 |
| „ 3 to 4 in. | 6 | 12 | 6 | 6 | 17 | 6 |
| „ 5 to 8 in. | 6 | 7 | 6 | 6 | 10 | 0 |
| „ 10 to 16 in. | 6 | 7 | 6 | — | | |
| „ 18 to 24 in. | 6 | 7 | 6 | — | | |
| Chairs | 4 | 7 | 6 | 4 | 10 | 0 |
| Floor plates (open sand) | 3 | 10 | 0 | 3 | 12 | 6 |

(At work).

## Non-Ferrous Metals.

| Copper. | £ | s. | d. | £ | s. | d. |
|---|---|---|---|---|---|---|
| Standard, Cash | 75 | 2 | 6 | 75 | 7 | 6 |
| Three months | 75 | 12 | 6 | 75 | 17 | 6 |
| Electrolytic | 88 | 10 | 0 | 89 | 10 | 0 |
| Tough | 87 | 10 | 0 | 88 | 10 | 0 |
| Best selected | 88 | 10 | 0 | 89 | 10 | 0 |

| Tin. | | | | | | |
|---|---|---|---|---|---|---|
| Standard, Cash | 163 | 10 | 0 | 164 | 0 | 0 |
| „ Three months | 162 | 12 | 6 | 163 | 2 | 6 |
| English Ingots | — | | | 162 | 10 | 0 |
| Bars | — | | | 163 | 10 | 0 |
| Refined | — | | | 167 | 0 | 0 |

| Spelter. | | | | | | |
|---|---|---|---|---|---|---|
| American | — | | | 78 | 0 | 0 |
| Specials | — | | | — | | |
| Hard | — | | | 57 | 0 | 0 |
| British | 78 | 0 | 0 | 80 | 0 | 0 |

| Lead. | | | | | | |
|---|---|---|---|---|---|---|
| Soft foreign | — | | | 24 | 10 | 0 |
| English | — | | | 25 | 10 | 0 |

| Antimony. | | | | | | |
|---|---|---|---|---|---|---|
| Regulus | — | | | 100 | 0 | 0 |

| Aluminium. | | | | | | |
|---|---|---|---|---|---|---|
| Virgin Metal, 98/99% per ton | 185 | 0 | 0 | | | |

| *Chromium (Metallic). | | | | | | |
|---|---|---|---|---|---|---|
| 98/99% purity per lb. | — | | | | | |

| *Nickel. | | | | | | |
|---|---|---|---|---|---|---|
| In cubes, 98/99% purity Per ton | 220 | 0 | 0 | | | |

| *Tungsten Metal Powder. | | | | | | |
|---|---|---|---|---|---|---|
| 96/98% purity per lb. | 0 | 5 | 10 | | | |

| *Molybdenum Metal. | | | | | | |
|---|---|---|---|---|---|---|
| 96/98% purity per lb. | — | | | | | |

| *Cobalt Metal. | | | | | | |
|---|---|---|---|---|---|---|
| 97% purity per lb. | 0 | 8 | 0 | | | |

| Quicksilver. | | | | | | |
|---|---|---|---|---|---|---|
| 75 lb. bottle | 16 | 13 | 9 | | | |

* Net, Delivered Sheffield Works.

## Scrap Iron and Steel.

### Cleveland.

| | s. | d. | | s. | d. |
|---|---|---|---|---|---|
| Steel scrap, heavy melting | 68 | 9 | to | 71 | 3 |
| Iron scrap cast (cupola metal) | 55 | 0 | | 56 | 0 |

### London (f.o.b.).

| | | | | | |
|---|---|---|---|---|---|
| Heavy steel | 65 | 0 | | | |
| Light „ | 50 | 0 | | | |
| Heavy cast | 60 | 0 | | | |

## Non-Ferrous Scrap.

London merchants quote the following prices for scrap metal, delivered London, and subject to market fluctuations: —

| | A. Joseph £ | s. | d. |
|---|---|---|---|
| Hy. Electrolytic Copper Scrap | — | | |
| Hy. Selected Scrap Brass | — | | |
| Hy. Tinned Copper Wire | — | | |
| Best Selected Gunmetal Scrap | — | | |

Re-melted Ingot Lead 30s. under English Lead price on date of order.

## Stocks.

### Pig-Iron in Public Store.

| | Oct. 4. Tons. | Inc. + or Dec. — since Oct. 7, 1914. Tons. |
|---|---|---|
| Connal's at Glasgow Scotch | 1,000 | No change |
| Ditto other makes | — | No change |
| Connal's at Middlesbrough | 129,420 | + 23,367 |
| Connal's at Middlesbrough, hematite | — | No change. |
| West Coast hematite.. | 2,120 | — 911 |

### Metals.

| | | |
|---|---|---|
| Copper, Europe and afloat | 30,008 | — |
| Tin, London, Holland, U.S.A. and afloat | 15,753 | + 2,625 |

## Coke.

### Middlesbrough.

| | s. | d. | | s. | d. |
|---|---|---|---|---|---|
| Gas Coke | — | | | 27 | 6 |
| Foundry Coke | 32 | 6 | to | 37 | 6 |
| Furnace coke | — | | | 26 | 0 |

### Newcastle-on-Tyne.

| FOUNDRY COKE— | F.o.b. s. | d. | Dunston s. | d. |
|---|---|---|---|---|
| Original Garesfield | 31 | 0 | 32 | 0 |
| Mickley | 31 | 0 | 32 | 0 |
| Stella Garesfield | 31 | 0 | 32 | 0 |
| Priestman's Garesfield | 31 | 0 | 32 | |
| Consett Garesfield | 31 | 0 | 32 | 0 |
| Newcastle gas coke | — | | 30 | 0 |

### Cardiff.

| | s. | d. | | s. | d. |
|---|---|---|---|---|---|
| Special foundry coke | 40 | 0 | to | 42 | 6 |
| Foundry coke | 34 | 0 | to | 38 | 0 |
| Furnace coke | 28 | 0 | to | 32 | 0 |

### Leeds.

| | | | |
|---|---|---|---|
| Furnace coke (washed) | — | 17 | 0 |

### Birmingham.

| | | | | |
|---|---|---|---|---|
| Foundry coke | — | | — | |
| Furnace „ | — | | — | |
| Gas „ | 21 | 6 | 22 | 6 |

### Glasgow.

| | | | | |
|---|---|---|---|---|
| Foundry coke | 31 | 0 | 32 | 6 |
| Furnace „ | — | | 26 | 6 |
| Gas „ | — | | — | |

### London.

| | | | |
|---|---|---|---|
| Welsh or Durham Foundry, d/d London Stations, in truck | — | 45 | 6 |
| Yorkshire, d/d London Stations, in truck | — | 33 | 0 |

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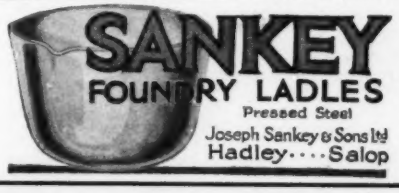


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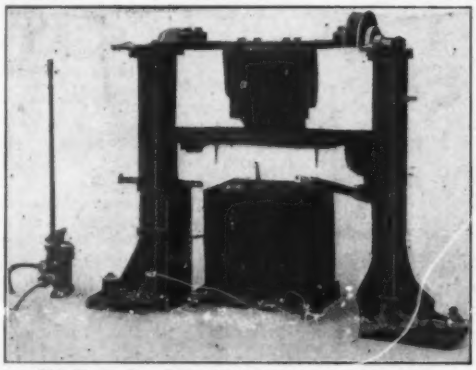

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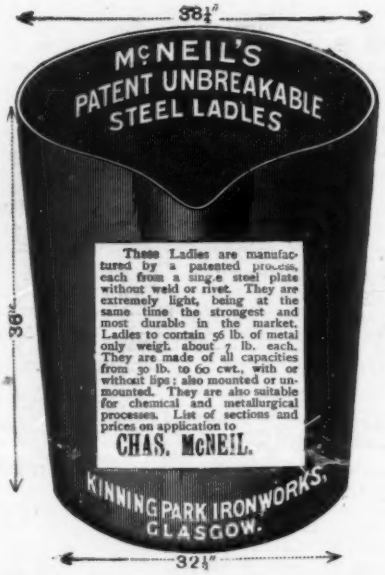
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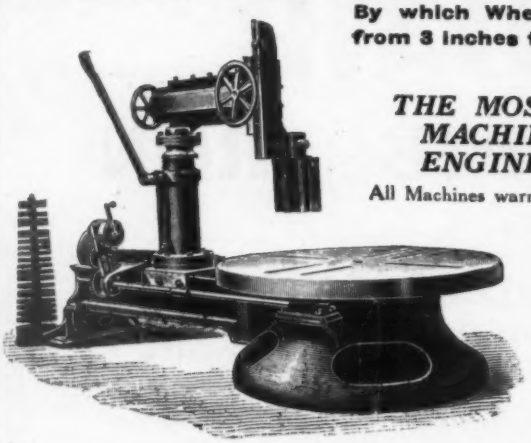

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